PROCEEDINGS

Fifty-Third Annual Convention

OF THE

American Railway
Bridge and Building Association

1948

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Proceedings of the
Fifty-Third Annual Convention

OF THE

American Railway Bridge and Building Association

Held at

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PROCEEDINGS

Following is a brief account of the 1948 convention in the form of a running story of the activities during the three-day meeting; brief abstracts of the addresses read to the joint sessions with the Roadmasters' Association; more complete abstracts of the addresses read before the B. & B. Association; and complete versions of all committee reports, with brief abstracts of the discussions that followed their presentation.

WHAT new problems has the increased use of Diesel locomotives created for the bridge and building forces? What practices in the housing of these forces contribute to improved employee morale? What have researchers to say about the possibility of getting better concrete? What are some of the economic problems involved in replacing timber trestles with other types of construction? These are some of the many questions that were answered in committee reports and addresses presented at the annual convention of the American Railway Bridge and Building Association, held at Chicago on September 20-22.

Why It Was Successful

This meeting was a notable affair for several reasons. It was the third to be held by the bridge and building group simultaneously with the annual convention of the Roadmasters' Association, both meetings being held in the Stevens hotel. Other factors combining to assure the success of the convention included the presence of the Railroad Fair at Chicago, and the scheduling by 13 committees of the American Railway Engineering Association of meetings in Chicago during the conventions in order that their members could have the opportunity of sitting in on sessions of particular interest to them. Some of the A.R.E.A. committees were also influenced by the presence of a large exhibit in the Stevens hotel at the time of the meetings. This exhibit featured the products of 93 member companies of the Track Supply Association and the Bridge and Building Supply Men's Association.

These special events helped to boost the total attendance at the two meetings to a new high since the practice was started of holding them simultaneously. The registration of members and guests of the two associations for the three-day period amounted to 900, which compared with a total registration of 765 members and guests in 1947.

The two meetings were convened in a joint session on Monday morning, September 20, which was presided over jointly by J. S. Hancock, bridge engineer, Detroit, Toledo & Ironton, and president of the Bridge and Building Association, and A. B. Chaney, assistant engineer maintenance of way, Missouri Pacific, and president of the Roadmasters' Association. All separate sessions of the Bridge and Building group were directed by Mr. Hancock, assisted by E. H. Barnhart, division engineer of the Baltimore & Ohio, and first vice-president of the association.

The principal feature of the joint opening session was an address by J. H. Aydelott, vice-president, Operations and Maintenance department, Association of American Railroads. At a subsequent joint session on Tuesday afternoon the combined groups heard an address by A. E. Perlman, general manager, Denver & Rio Grande Western, who spoke on "How the Roadmaster and Bridge and Building Supervisor Can Help Hold Down Maintenance Costs." A second address during the same joint session was presented by O. H. Carpenter, general roadmaster, Union Pacific, who spoke on "Safety Problems as Affected by Diesel Operation and the Increased Mechanization of Maintenance Work."

Remarks by the President

Addressing the opening separate session of the Bridge and Building Association, President Hancock, explaining that he was deviating from the usual practice of giving an account of his stewardship for the year, spoke of the accomplishment of the association in "coming through two major wars and a major depression within a period of 20 years, emerging in a condition to stand on its own feet." He expressed the hope and belief that "this organization can soon reach the place where railroad management will consider its existence imperative."

The president urged members to assume committee work willingly and to contribute freely of their knowledge. He also requested their cooperation in obtaining new members, saying that this can be done better by personal contact than in any other way. As the result of a membership drive directed by W. F. Martens, general foreman of bridges and buildings, Atchison, Topeka & Santa Fe, San Bernardino, Cal., and second vice-president of the association, a total of 97 new active members were added last year and 144 new members this year, said President Hancock.

He then read excerpts from a letter received from F. M. Misch, general bridge and building supervisor, Southern Pacific, who described how he had enlisted the cooperation of the management of his road in organizing local meetings of the bridge and building supervisory officers on his road for the purpose of reviewing the committee reports and other material presented at the convention last year. This was done for the benefit of West Coast members who were unable to attend the convention.

Mr. Misch said that the first meeting was held in Tucson, Ariz., on January 8, 1948, and that those present included all of the supervisors and assistant bridge and building supervisors from the company's southern divisions, a total of 16 employees. The next meeting was on January 21, 1948, in San Francisco, at which time all of the bridge and building supervisors and assistant bridge and building supervisors from all northern districts were present, a total of 27.

Principal items on the agenda of the separate sessions of the Bridge and Building Association included two addresses and eight committee reports. George M. Hunt, director, Forest Products Laboratory, U. S. Department of Agriculture, Madison, Wis., spoke on "The Protection of Wood in Railway Bridges and Buildings," and Dr. Ruth G. Terzaghi spoke on the question: "If the Railroads Are Not Securing Good Concrete—Why?"

The following subjects were covered by the eight committee reports: "Good Housekeeping to Promote Safety and Fire Protection"; "Protection to Bridges Over Navigable Streams"; "Types of Bridges for Replacing Timber Trestles"; "Enlarging and Relining Tunnels for Present-Day Traffic"; "Housing Bridge and Building Employees"; "Recent Developments in Fuel-Oil Storage and Servicing Facilities for Diesel and Oil-Burning Locomotives"; "Sanitary Facilities and Appurtenances for Railway Buildings"; and "Eliminating Waste of Water."

Another item on the program was a motion picture entitled "Mortar and Glass." Produced by the American Structural Products Company, a subsidiary of Owens-Illinois Glass Company, this picture demonstrated the proper method of laying up glass block panels.

At the Monday afternoon session a certificate of honorary membership in the association was awarded posthumously to the late C. R. Knowles, formerly superintendent of water service of the Illinois Central and treasurer of the association. The presentation was made by Guy E. Martin, present superintendent of water service of that road.

An interlude in the three days of business sessions was a banquet on Tuesday evening, which was tendered to members of the two associations and their families by the Track Supply Association and the Bridge and Building Supply Men's Association. This affair was attended by 1230 persons.

New Officers Elected

In the election of officers at the closing session Mr. Barnhart was advanced from first vice-president to president; W. F. Martens was advanced from second vice-president to first vice-president; W. A. Huckstep, general building supervisor, Missouri Pacific, St. Louis, Mo., was promoted from third vice-president to second vice-president; Guy E. Martin was advanced from fourth vice-president to third vice-president; F. R. Spofford, assistant division engineer, Boston & Maine, Dover, N. H., was elected fourth vice-president; and L. C. Winkelhaus, architectural engineer, Chicago & North Western, Chicago, was elected treasurer. Directors elected were: H. M. Harlow, assistant general supervisor bridges and buildings, Chesapeake & Ohio, Richmond, Va. (reelected); V. E. Engman, chief carpenter, Chicago, Milwaukee, St. Paul & Pacific, Savanna, Ill.; and G. W. Benson, supervisor bridges and buildings, Central of Georgia, Macon, Ga.

Eight subjects were chosen for investigation by committees during the coming year as follows: "Installation and Maintenance of Built-Up Roofs";

"Fire Protection for Bridges and Trestles"; "Safety in the Transportation of Men and Materials"; "Prolonging the Life of Ties on Bridges and Trestles"; "Developments in Modern Methods for Watering Passenger Cars"; "Methods of Preventing and Removal of Corrosion from Steel Structures"; "Pier Construction and Maintenance on Waterfront Terminals"; and "Disposal of Liquid Waste at Engine Terminals."

Indicating that the practice of holding this convention concurrently with that of the Roadmasters' Association is proving highly satisfactory is the decision to continue the practice next year. The tentative dates for the convention to be held in 1949 are September 13-15.

Brief abstracts of addresses by Messrs. Aydelott, Perlman and Carpenter, at the joint sessions and more complete abstracts of addresses by Dr. Terzaghi and Mr. Hunt at B. & B. sessions are presented on succeeding pages, followed by the committee reports in full, with brief abstracts of the discussions from the floor.

Advice to Supervisors

THE GREATLY increased unit costs of track and bridge repairs have brought about a need for the closest possible supervision, said Mr. Aydelott in his address before the joint opening sessions. It is no longer sufficient for a roadmaster or a master carpenter to maintain a set schedule for inspection duties in his territory, he said. The various gangs should be checked at times when they are not expecting the supervision to be near.

Mr. Aydelott said he had heard the argument produced on several occasions in behalf of maintenance of way employees that they should have higher wages because of the increased productivity due to skills acquired in present-day maintenance. In view of such arguments, he said, "it behooves the roadmaster and the master carpenter to see that his railroad gets a full day's work for a full day's pay lest his program suffer."

On several occasions during his comments Mr. Aydelott paid tribute to those comprising his audience. At one point he said that, in the use of manpower and materials, "no individual group on the railroad has the opportunity for economies that lie in your hands." At another point he said that "the roadmaster perhaps more than any other individual on his property, is in a position to suggest where maintenance money might be saved by realinement for the purpose of reducing wear and tear on the track and equipment and from improved drainage."

Other matters discussed by Mr. Aydelott included the large savings being realized by the railroads as a result of the means developed for lengthening the life of ties; the research program that the Association of American Railroads has undertaken in collaboration with the lumber manufacturers to determine if still further life can be obtained from ties; research activities of the A.A.R. looking to improvements in rolling stock; and the plans for the association to start construction soon on a new central research laboratory to be located in Chicago.

The Supervisor and Maintenance Costs

THE IMPACT of a peace-time economy, with its emphasis on holding costs down, has made it necessary for railroad maintenance men to examine closely their methods and practices, according to Mr. Perlman. He warned against blindly following standard plans and procedures by quoting: "After something has been in effect in your organization for two years, look it over carefully. After five years, look it over suspiciously. And after ten years, throw it out and start all over again."

Continuing, he said, on your way home, if you pass over the other man's railroad, try to take something of value that can be put into effect on your own road. He stated that the sight of a half-yard dragline cleaning cuts on an eastern short line was responsible for revolutionizing the Rio Grande's maintenance operations whereby the use of off-track work equipment helped give them one of the lowest maintenance ratios in the west.

Speaking of the supervisor, Mr. Perlman indicated that the factor that can do more toward reducing maintenance costs than any other is conscientious and open-minded on-the-ground supervision of all activities under his supervision. Thus he becomes fully familiar with the men, methods and materials, which go to make up each operation and will have all the facts at hand with which to make decisions.

Relative to the foreman, Mr. Perlman advised the supervisor that each foreman is an individual, subject to his influence and example, and they require constant study to get the right man in the right job. Have men in your organization who know more about certain phases of the work than you; they add to your effectiveness. If you came up through the ranks, try to add some technical graduates. If you are technically trained, gather around you the best practical talent you can obtain and heed carefully their advice. Take in as many young men as you can absorb.

Machines and Safety

"A GOOD safety record is the result of the team work of everyone concerned, from top management down through the ranks to the lowest paid employee on the payroll," said Mr. Carpenter in his address before the joint session on Tuesday afternoon on Safety Problems as affected by Diesel Operation and Increased Mechanization of Maintenance Work.

After stating that, in his opinion, "it can be clearly shown that the reduction of killed and injured employees pays in a cold calculation of dollars and cents," Mr. Carpenter went on to describe in some detail the organization and methods by means of which employees on his road are taught to work in a safe manner.

Rather than experiencing any increase in accidents due to the advent of the Diesel locomotive, Mr. Carpenter said that the record had improved, the reason being that trains are more apt to arrive when they are expected, and "long aggravating waits for overdue trains are not so frequent."

The increased use of power machines has had a favorable effect on safety performance, according to Mr. Carpenter. "In fact," he said, "the more hand tools we can eliminate the better will be our safety record. The use of power tools is just as advantageous from a safety standpoint as from a standpoint of economy or efficiency." However, he said that there are "some new problems to be met in the increased use of power machines," and went on to refer to several of these, including the handling of fuel, assuring the integrity of the cables and slings used with cranes, the handling of machines on and off the track manually, the possibility of workers' clothing or parts of their bodies becoming engaged in moving parts of machines, and the cranking of engines.

If the Railroads Are Not Getting Good Concrete—Why Not?

By Dr. Ruth D. Terzaghi

WHAT is good concrete? A few years ago the term "good concrete" was applied to concrete which had a high compression strength, and the generally accepted measure of quality was the 28-day strength of test specimens, prepared either in the laboratory or taken at the mixer.

The maximum obtainable 28-day strength of concrete has gradually increased from decade to decade, since the early days of cement manufacture in this country, owing to progressive changes in the composition and method of manufacture of cement. This increase in strength is strikingly demonstrated by the results of a series of tests, published by the Portland Cement Association in 1933. These tests were carried out between the years 1916 and 1931. At intervals within this period cements of 4 or 5 different brands were blended. Concrete test specimens were made with the blend, according to uniform specifications. The average 7-day strength of the specimens prepared in the five-year period from 1916 to 1920, inclusive, was only 1500 p.s.i. The specimens made in each succeeding period show a progressively higher 7-day strength, and by 1930-31, the average 7-day strength had reached 3600 p.s.i. The corresponding figures for the 28-day strength were 3000 lb. for the period 1916-20 and 5000 lb. for 1930-31. This result was hailed as a sign of progress and there was no doubt in anyone's mind that the quality of the cement had been greatly improved.

Is Early Strength Necessary?

Two factors have combined to cause us to question the wisdom of measuring the quality of concrete on the basis of its early strength. One is the realization that early strength is not an accurate measure of late strength, because the strength of a low-early-strength-cement concrete may ultimately approach if not overtake that of a high-early-strength-cement concrete. However, before we abandon the 7-day or 28-day strength tests as a measure of concrete quality, we should give very serious consideration to the advantages of early strength in standard portland cement concrete. How much is it worth to the man on the everyday concrete job to have his concrete harden rapidly, to a strength, let us say, of 3600 p.s.i. in seven days. Would he be seriously handicapped if he had to work with a more slowly hardening concrete? I shall not attempt to answer this question. I merely place it before you who are ideally fitted by your experience to estimate the value of the relatively high rate at which modern standard portland cement concrete develops its strength. I am, of course, not speaking here of the special type of high-early-strength cement which is of obvious value for emergency repair work and other special jobs. As I shall point out later, there are reasons for believing that we may be paying for at least a part of the high-early strength of modern concrete by sacrificing durability. We do not yet know just how high the price is, but while we researchers are trying to find out, the field man, for his part, should make up his mind as to how much early strength he really tell us to what extent we must still measure concrete quality by its early strength.

A still more important item has caused us to question the validity of early strength as a measure of quality. This is our bill for the repair and maintenance of concrete structures, which runs to millions of dollars for the railroads alone. Without respect to the size of this bill, I think we will all agree, at least for the purposes of this discussion, that good concrete is durable concrete.

What are the causes of the lack of durability of concrete?

It is a relatively simple matter—on paper—to divide the causes of concrete deterioration into four groups: aggregate, cement, concrete manufacturing process, and the environment. In practice, causes of all four overlap and interlock in such a way that it is almost impossible to point to a single cause as the culprit. Nevertheless I shall try to separate the causes of deterioration into these four groups, and at the same time indicate how the various causes are inter-related.

With few exceptions, the defects of concrete which we attribute either to the aggregate, to the cement, or to the concrete manufacturing process, have one aspect in common: they are the result of stresses in the concrete. These stresses are due to unequal volume changes in the concrete mass, which induce cracks in those portions of it which contract more or expand less than other parts. As soon as these cracks have developed, the environment takes hold, and rain, snow, frost action, seepage, acid waters, sea water and alkali waters gain access to the concrete through the cracks and the attack of these agents is greatly intensified.

Aggregate as a Cause of Deterioration

Since aggregate constitutes roughly 85 per cent of the volume of concrete, it is obvious that defects in the aggregate may produce important defects in the concrete. Our own experience in examining your structures gives an approximate idea of the prevalence of deterioration, due to poor aggregate. Sixty-five structures in various parts of the country have been examined in some detail. Of these 35 per cent show more or less serious defects caused by poor aggregate.

In regions where only one kind of aggregate is available, economic considerations may force its use. In other regions, however, there may be several sources of aggregate, and it becomes the duty of the engineer to pick the best of the available material. He may make his choice in one of two ways. Either he may rely on the service record of the aggregate, if it is from an old established source, or he may rely on the results of laboratory tests. Unfortunately, neither method is perfect. Reliance on service records may be dangerous, for two reasons. Identical aggregates may give good service when combined with one cement and fail miserably when combined with another. This is particularly true of those aggregates which react with the potash and soda present in large amounts in some cements, but it may also apply to other types of potentially troublesome aggregate. The second reason why service records may not provide an accurate guide to aggregate quality is found in the variations within deposits. Recently I was asked to examine some specimens of Ohio River gravel, to determine the suitability of the material for use as concrete aggregate. I was told of a number of structures built with Ohio River gravel, which are still in excellent condition after forty or more years of service. The trouble was that the Ohio River gravel in these structures bore no resemblance whatsoever to the specimens I had to examine. The Ohio River gravels in many of these older structures represented deposits of rocks carried southward by glaciers and glacial streams; they consist largely of sound, hard igneous rocks and contained little or no chat. The specimens which I had to examine came from a deposit made by the present Ohio River, and consisted chiefly of sedimentary rocks, including a large percentage of chat and iron concretions, both of which cause pop-outs.

The second method of finding out whether aggregate is suitable for use in concrete is to have it examined by a qualified laboratory. Such a laboratory must be equipped to conduct routine physical tests, such as sodium sulfate and abrasive tests. Also it must have on its staff a competent petrographer, a specialist in the study of rocks, who can interpret what he sees in terms of concrete technology. Routine tests in many cases do not suffice to distinguish between good and bad aggregate, hence these tests must be supplemented by microscopic examination of the aggregate.

The results of research carried out in some of the larger testing laboratories, like those of the Bureau of Roads and of the U. S. Corps of Engineers, have led and still are leading to the detection of so many different types of undesirable aggregate, that the concrete technologist finds it increasingly easy to say "no" to a great variety of aggregates. Naturally, this situation is discouraging to the man who wants to make concrete, and those of us who are interested in the examination of concrete aggregate are realizing more and more that we must not only reject aggregates; we must also develop ways in which they can be used, even if they are not ideal.

To illustrate, consider a structure the poor condition of which is due to a so-called reactive sand—that is, a sand which contains small bits of opal which react with the cement, take up water and thus expand, long after the concrete has set. If this sand had been tested by any of the chemical or other tests now used in some laboratories for the detection of reactive aggregate, it doubtless would have been rejected. However, a satisfactory solution might have been found if the sand had been examined microscopically. Such examination would have shown that the destructive elements in the sand were present chiefly in the fraction passing the No. 100 sieve, which could easily have been removed by washing.

If the selection of suitable aggregate requires a lot of elaborate laboratory equipment, and some highly trained specialists to use it, you may wonder why I'm taking up your time with the subject. Your business is making concrete, not testing aggregate. But if you are putting everything you've got into making good concrete, you deserve the assurance that your aggregate is not going to let you down. If the best aggregate you can get isn't all it should be, you deserve whatever help science and technology can give you in finding out how to use it with the best possible result. Just how and where you are going to get that unbiased kind of help, I don't profess to know. But you owe it to yourselves and to your railroads to see that it is made available to you.

Is Cement the Cause of Poor Concrete?

A second possible cause of lack of durability in concrete is to be found in the properties of the hydrated cement—or the paste. This has become a popular topic in the last few years and it has been a source of many arguments. Some engineers contend that cement is not as good as it used to be, either before 1930 when fine grinding became prevalent, or in some less definitely specified past time. Others reply that this is just another "good old days" fallacy.

There are two ways of trying to settle this argument, and we shall have to use them both before we are through with it. The first is to examine a large number of concrete structures exposed to comparable conditions and built in a similar way, some before 1930, or some other date supposed to be the dividing point, and some after that date. F. H. Jackson of the U. S. Public Roads Administration has made a study of this sort and he found that about ⅔ of a group of structures built before 1930 were in good condition, whereas only about ⅓ of those built after 1930 in the same region were in good condition. The results of this study are extremely significant, but we need many more like it.

There is considerable difficulty in applying this method to railroad structures, because many organizations used a wet mix right up to 1928 or 1929. Hence the number of structures comparable in quality to those built later is very limited. After 1930, on the other hand, few structures were built owing to economic conditions.

Another way of determining the effect of changes in the cement or the lack of durability in concrete is to investigate the changes which have taken place in the properties of the cement paste as a result of changes in the cement. In this connection, we are particularly interested in those properties of cement and of paste which constitute its weaknesses, particularly those causing volume changes.

Consider first expansion and contraction due to wetting and drying and to heating and cooling. Volume changes probably would do little or no harm to concrete, if they took place uniformly. Unfortunately they never do, and they never can, take place uniformly. There are two reasons for this. Even the smaller body of concrete is so thick that the surface can become almost completely dry while the interior is still saturated. The surface can also be much warmer or much colder than the interior; still more important, aggregate either doesn't change volume at all on wetting and drying, or it changes too much. Furthermore all aggregate expands less on heating and contracts less on cooling than the paste.

The effect of these volume changes of the paste can be visualized if we imagine a sphere consisting of a rock which undergoes no volume change due to wetting and drying, and a very small change due to heating or cooling.' We heat the sphere, say to 120 or 150° F. and apply to it a coating of paste or mortar having the same temperature. If we let the sphere with its coating cool quickly, and also let the coating dry quickly, cracks will develop in the coating very promptly. If we wish to avoid cracks in the coating, we take care not to allow the temperature of the sphere to get too high, and we keep the coating continuously moist for several weeks—that is, we cure it carefully. If we pull our sphere through that first period of cooling and drying, we are justified in feeling that we have won more than half the battle. However, that sphere is put out of doors, where it will go through countless cycles of wetting and drying and heating and cooling. According to tests carried out in the Bureau of Roads and the U. S. Corps of Engineers' laboratories, these may be just as destructive as freezing. Hence the expansion and contraction of the cement paste due to wetting and drying and heating and cooling has an important bearing on the durability of concrete.

Consider next—heat of hydration. Both the total heat developed, and the rate at which it is developed are important. The heat of hydration is one of the undesirable properties of cement. And how has it changed? Finer grinding has resulted in a slight increase in the total heat of hydration, because fine grinding results in more complete hydration. It has resulted in considerable increase in the rate at which heat is released, simply because hydration takes place more rapidly. Now on top of this, comes an increase in the tricalcium silicate content, which causes an additional increase in the heat of hydration.

The increase in the heat of hydration is particularly important in the case of large structures; the inside becomes hot and expands, the outside is kept fairly cool, and since it doesn't expand much, it cracks. Now, how have we reacted to this increased danger of cracking due to temperature differences? We hurry our structure along, by making bigger batches of concrete, and feel proud if we can beat the construction schedule. We must ask where is the heat going to go, if we keep on piling up batch after batch of concrete? Well it doesn't go anywhere, it stays right in the concrete which becomes hotter and hotter. There is only one thing to do about it: limit the thickness of lifts. If the cement is one which develops a moderate quantity of heat, for instance a modern type 2 cement, you can get away with 5-ft. lifts, providing you can place your lifts at an interval of not less than one week.

Some years ago an investigation was made of a number of cements in order to find out how much the paste made with them would expand on heating. It was found that variation in the composition of the cement had little effect on the thermal expansion unless there was a change in the tricalcium silicate; increasing the tri-calcium silicate led to a considerable increase in the expansion. Considering the progressive increase in tricalcium silicate content which has taken place since 1880, it is clear that a corresponding increase must have taken place in the coefficient of thermal expansion. [At this point in the address a slide was shown which represented diagramatically the coefficient of expansion of quartz and that of the average volume for some common types of aggregates. The slide showed that in 1880 there was much less difference between the coefficient of expansion of the paste than that of the common aggregate types. Also that there were very few aggregates then which had a coefficient as far below that of the paste of that time as the coefficient of quartz is below that of the paste of our time. Dr. Terzaghi stated that recent experience has shown that trouble results if we try to use aggregates having coefficients of expansion 6 to 7 millionths lower than that of the paste.]

Another undesirable feature of the paste is that part of it is readily soluble. This part is the calcium hydroxide which is formed when the cement hydrates. Long streaks of this soluble material are a familiar sight on concrete surfaces subject to seepage, and the more this soluble material is leached out, the more porous the concrete becomes, and a vicious cycle of leaching and consequent weakening is set up.

Now let us inquire what changes may have been brought about in these critical properties of the paste. As a result of changes in manufacturing two significant changes have taken place in the cement. The one about which we hear most is the introduction of finer grinding around 1930. The second is the gradual increase in the lime content of the cement. When the lime content of the cement is increased, the quantites of two of the important constituents of the cement are changed. These are the dicalcium silicate and the tricalcium silicate. Increasing the lime content increases the tricalcium silicate and decreases the dicalcium silicate. Since these two substances have quite different properties, increase of one at the expense of the other may have a far-reaching effect on the properties of concrete.

Only time and a great deal of investigation will tell how many failures and near failures have been hastened or caused by what we begin to call thermal incompatibility of aggregate and paste. If it really turns out to be as important as we now suspect it is, we shall certainly have to question very seriously the wisdom of increasing the early strength of concrete by increasing the tricalcium silicate content. We may find that we don't want to pay for early strength by a sacrifice of durability. Hence at the beginning of my talk, I asked you to consider how much the high early strength is worth to you. Your answer may have an important bearing on the future of concrete.

What Can We Do About It?

We have seen that there really is evidence to suggest that our modern cement requires, in some ways, more care in handling than the older cements. Perhaps the situation isn't as bad as it looks. Perhaps it's worse. But in any case, whether we like modern standard cement or not we are stuck with it, and we are going to be stuck with it for years to come. So we might as well stop passing the buck and buckle down to business to see what we can do about it.

But before discussing the best way to offset the apparent weakness of modern cement I wish to review some of the causes of trouble which have already been described. In connection with aggregate, we have the problem of excessive increase in volume of some types of shales, certain altered granites. iron oxides, and reactive aggregate, including opal and volcanic glass. The expansion of these is a reaction in which water takes part. Then we have the aggregates which contain some substance which is harmful to concrete, such as gypsum, iron sulphide—these harmful substances cannot migrate from the aggregate to the concrete unless free water is present to carry them. Hence we have the need to exclude water from the concrete. Then we have the aggregate which contracts less than the paste or the mortar when both are cooled and dried. This, of course, is just another way of saying that the mortar contracts too much. Here are two birds to kill with one stone. The way to keep free water out of concrete —that is, to make it relatively impervious—and the way to reduce its drying contraction is to keep the mix dry in the first place, and to place it with all the art and knowledge and skill we possess. These factors, dry mix and good workmanship, sufficed fifty years ago to make concrete that would take quite a beating. New England and other parts of the country blessed with a rugged climate can boast concrete structures which are flawless monuments to their builders—after the freezing of fifty winters, climate cycles of every kind, and without benefit of specialists who reject aggregates right and left. Maybe the same kind of workmanship will produce the same kind of concrete today. Maybe it won't. But one thing is certain. The one way to find out is to try it. Of course we have to recognize one difference between today and 1900. We have our modern idea of speed, and we are stuck with that. But we also have modern aids, such as air entrainment, the vibrator and curing compounds. These won't get any results that the old style brand of workmanship didn't get, but they will help us to get them more easily and more quickly. However, we must regard them not as cure-alls but merely as aids for the production of flawless impervious concrete, which will undergo a minimum amount of expansion and contraction.

The Protection of Wood in Railway Bridges and Buildings

By GEORGE M. HUNT, Director

Forest Products Laboratory, Forest Service
U. S. Department of Agriculture

CURRENTLY the most significant fact about wood and its use in railway structures is its high cost, also the high cost of the labor to build it into useful structures. This places new importance on methods of avoiding wood waste, of making wood give longer service, and of reducing labor costs in building and maintaining wood structures. It justifies a reconsideration of many old truths, some of which may have been forgotten or not used to maximum advantage when lumber and labor were cheaper. It is not only the average life of a structure and the cost of replacement that need to be considered, but also avoidance of repairs. Periods of high cost and material shortages, such as the present, are not the time for luxuries and unnecessary expenditures, but they are times for making all materials, including wood, give the utmost in service.

Build for Longer Life

If you can be sure that materials and labor will be a lot more plentiful and cheaper during the next few years than at present, you can afford to build short-lived structures now and replace them at lower cost when they need renewal. However, the wisest course is to assume continued high costs and to take advantage of every opportunity to get longer life from your structures, and lower annual and maintenance costs. Quite often, spending more money on first cost will result in lower annual costs and fewer repairs. More study should be given to annual costs. Too many users do not know how much service they are getting from their structures and what they are costing per year.

Most of you are familiar with the means of insuring longer life, that is, the creosoting of bridge timbers. Are all your bridges treated? Are your specifications devised to give lowest first cost or longest life? Probably you have tried to get a balance between them, but have you succeeded? If your practice is to use treated wood and to specify 10 pounds or 12 pounds of creosote per cubic foot, how much more would a completed bridge cost if you increased the required retention by 2 to 4 pounds? The percentage increase in cost of the completed structure would be relatively small and, in my opinion, greatly outweighed by the increased assurance of long life without repairs because of decay. Where you have not been using treated wood, the opportunity for savings by treatment is even greater.

Other factors to be considered

As the creosote retention increases, the tendency toward bleeding increases, other things being equal. If your determining factor is avoidance of bleeding you cannot use high creosote retentions satisfactorily. Where bleeding cannot be tolerated perhaps you should use some other preservative than creosote. Similarly, where fire hazard must be kept low regardless of other considerations, high creosote retentions, with their possible increased bleeding, may not be acceptable unless some noncombustible covering is applied for fire protection over the creosoted wood. But, when maximum life is the primary objective in outdoor structures, don't spare the creosote. This is true especially in piles used in salt water. For that purpose, use good creosote, pump in all the wood will hold, and make sure, through adequate and competent inspection, that you get what you specify.

Creosote retention is not the whole story by any means, for penetration or distribution is just about as important. A 12-pound full cell treatment is less likely to give good penetration and distribution than a 12-pound empty-cell treatment of the same material, yet I think there are still a few people who are misled by the term "full cell" into thinking it is superior to empty-cell treatment. The reverse is actually true except for retentions higher than possible by means of empty-cell methods.

Several Types of Preservatives

Creosote is not the only preservative and will not meet all needs. We have other and newer preservatives that are superior to creosote from the standpoint of cleanness, although they have not yet had time to demonstrate that they give equal or longer life. I see no hope of ever finding a preservative so revolutionary that brush or dip treatments with it will give the same protection as pressure treatments with present preservatives. Good penetration and adequate retentions are just as necessary with our newest preservatives as with our oldest ones. The same retention is not required of all preservatives, but with any preservative there must be enough and it must be well distributed in the wood.

I believe we are making steady progress in the development of new and superior preservatives, but it takes a long time to establish superiority because the old preservatives, in their respective fields, give such excellent results.

In addition to byproduct oils like coal-tar creosote, creosote solutions, and the like, we have two groups of new materials worth watching. One group consists of highly toxic chemicals dissolved in petroleum oils or other solvents. This group includes pentachlorophenol, copper napthenate, and other oil-soluble toxic chemicals. Although pentachlorophenol and copper naphthenate have not been officially accepted as the equal of coal-tar creosote in effectiveness against fungi, they are giving excellent promise. During the creosote shortage of 1946 they were used in large amounts, particularly in the treatment of poles, Surprisingly, their use did not decline in 1947, when creosote began to be more plentiful. They have the common advantage of being definite chemical compounds which are reasonably easy to produce and identify. Their solution concentrations can be determined readily and accurately by chemical analysis. The solvents used and the concentrations can be varied, according to the needs of the product treated. Freedom from bleeding can be assured by suitable choice of solvent.

Pentachlorophenol seems to be ineffective against marine borers. Copper naphthenate appears somewhat better in this respect, but not to the extent that it can be approved for use in salt water. The problem of insuring long life for piles in salt water is much harder to solve than the problem of long life in land or fresh water use. Thus far, no other preservative approaches coal-tar creosote or creosote-coal tar solution in dependability for the purpose.

Water Soluble Preservatives

The second group of new preservatives of promise comprises water solutions of mixed chemicals which, after injection into the wood and subsequent seasoning, deposit mixed salts or double salts that are highly resistant to leaching and, at the same time are highly toxic to fungi and insects. The treating solutions usually contain salts of two or more of the following elements: arsenic, copper, chromium, and zinc. The salts are held in solution by the presence of a volatile acid or ammonia, which disappears as the wood seasons after treatment and allows the formation of the insoluble salt. A similar result can be achieved by treating first with one chemical, then with another.

An early preservative of this general type was zinc meta arsenite which is less used now than a few years ago, partly, perhaps, because of the technical difficulty of insuring the formation of the insoluble salt in the wood.

Preservatives of the double-salt type that appear to have the desired insolubility in greater or less degree include Celcure (containing copper and chromium), Greensalt or Erdalith (containing copper, arsenic, and chromium), Chemonite (containing copper and arsenic), and Boliden salts (containing arsenic, chromium, and zinc). Each preservative has its inherent advantages in cost, ease of technical control, corrosiveness, degree of effectiveness and other properties and, when properly used, will give a high degree of protection. They constitute definite evidence of progress.

Water-Repellent Preservatives

A class of preservatives that has gained some prominence during the last decade is the group known as water-repellent preservatives. They are designed primarily for the protection of millwork and related items, such as window sash and frames, doors, flooring, interior trim, and the like. Usually the treatment is simply immersion for a short time. The preservatives consist of a toxic chemical, such as pentachlorophenol, dissolved in a volatile solvent, to which waxes and other materials have been added for the prevention of "blooming," and for retarding moisture changes. The effectiveness of these preservatives against decay and insects is limited by the absorptions and penetrations obtained, but in window sash and doors they provide considerable protection even when applied by simple immersion. This is because the vulnerability of such items is primarily in their joints, where penetration is most easily obtained. Where the highest degree of protection is needed, more effective impregnation methods must be employed. High absorptions of oil solvents in millwork and similar items may, however, interfere with subsequent painting or finishing, unless a long time can be allowed for the solvents to evaporate before painting.

Water-repellent preservatives do not moistureproof wood, but they retard the rate at which moisture changes take place and thus slow down the rate of shrinking and swelling. This retardation may prove useful in situations where the humidity or the exposure to wet and dry conditions fluctuates frequently. It cannot have much effect, however, under long exposure to either wetness or dryness. Under constant exposure to the same conditions both treated and untreated wood reach the same moisture content, but the untreated wood gets there first.

Fire Retardant Treatment

In the protection of wood from fire there is definite progress, but I know of no revolutionary new development. There seems to be a growing appreciation of the importance of precautions to prevent or control fire, as a means of saving life and property. Treating structural timbers and building lumber with fire retardants found limited use before the last war and was confined almost entirely to the vicinity of New York City, where laws restricted the use of untreated wood. During the war, there was a great upsurge in the use of fire-retardant-treated wood in dirigible hangars and other war-born structures. At the peak of this development in 1943, over 65 million board feet of lumber and timbers were given such treatment. Since that time the use of fire-retardant-treated material has fallen off greatly, although it still remains higher than before the war.

One obstacle to the increased use of fire-retardant impregnation is the relatively high cost, caused in part by the high retentions of salts required. For maximum effectiveness, from 4 to 6 pounds of salts per cubic foot of wood are required, the higher retentions being needed for the smaller sizes. Considerable resistance to flame spread can be obtained, however, particularly in the larger sizes, with retentions of 2 or 3 pounds per cubic foot. A second obstacle is the leaching to which fire-retarding salts are subjected when the treated wood is exposed to the weather or used under wet conditions. A fire-retardant composition in which high effectiveness and high resistance to leaching are combined would be a revolutionary development, particularly if of moderate cost. A recent step in this direction is the use of a fire-retardant, water-repellent sealer, pressure-impregnated into the wood after treatment with fire-retarding chemicals. Encouraging results in retarding leaching by this method were reported at the last meeting of the American Wood Preservers' Association.

Fire-retarding coatings for surface application to completed structures have been improved considerably in recent years. In general, they are not suitable for outdoor use but limited progress is being made in that direction. The most effective fire-retarding coatings, when used indoors and properly applied, will give a high degree of protection from the rapid spread of fire.

Fire protection of bridges and other outdoor structures is highly important and can be provided by the intelligent use of fire walls, application of noncombustible materials over the wood, and by other methods that I believe you understand better than I.

Seasoning and Storage of Wood

In view of the high cost of materials and labor, it is wise to review the methods of seasoning and storage of lumber and timbers to see what losses are being sustained and how they may be reduced or prevented. Loss in seasoning and storage can be reduced to an extremely low figure if every possible method of preventing loss is applied. Protection costs can run so high, however, that they would be greater than the losses of material that might be sustained. The cost of protection against deterioration in seasoning and storage can be brought to zero by making no provision for protection, but that would usually result in serious loss or degradation of material and cost too much in loss of material. The job, therefore, is to get the best balance between cost of protection and the cost of lack of protection.

The amount of money that can be invested profitably to prevent deterioration of material will depend upon the value of the material under consideration and the difficulty of obtaining additional supplies. It will also depend in part upon the character of the lumber or timber, for some kinds can stand more abuse than others. High grade flooring, finish lumber, window sash, doors and millwork, for example, soon go bad if left out in the weather. They must have dry storage and protection from the weather if they are to remain long in usable condition. On the other hand, bridge ties, bridge timbers, and piles can stand considerable weathering without serious deterioration, if piled and stored correctly.

For the most part we must still depend upon kiln drying for the seasoning of lumber for use in floors, doors, interior trim, and similar purposes. For best results, the kilns must be in good repair and controlled by skilled operators.

As you know, there are several ways of conditioning lumber for treatment, including air drying, steaming, and the Boulton or boiling-under-vacuum method. Steaming and Boulton treatment do not remove much water but they do condition the wood so it accepts treatment. The Boulton method is used mainly with Douglas-fir, but has been employed successfully with other softwoods and some hardwoods. The steaming method is not suitable for hardwoods, and with many softwoods must be used with considerable care. Air drying has the advantage of simplicity, but much deterioration may result through decay or severe checking, especially with species that are particularly vulnerable. Steaming and Boulton treatment must likewise be used with care to avoid severe damage but each provides a method of treating green timber without waiting 6 to 12 months for seasoning.

Vapor Drying

Within the last few years M. S. Hudson developed a new method for the prompt treatment of green timber that depends upon the ability of the vapors of organic liquids at high temperatures to remove water from wood. The Hudson method is now in commercial use in treating green southern pine poles and green hardwood ties. More must be learned about the economics of the process and its advantages and disadvantages for different species and forms of timber before it can be recommended for general use. As used to date for poles and ties, however, it appears to be giving good results and is gradually finding wider use.

Drying by Boiling in Oil

Another method, consisting of boiling green pine lumber in a specially selected oil, is being promoted in the southern states and has found limited use. It is well known that water can be removed in this way, for the method has been used in some form or other for many years. Much remains to be learned about the economy of this new adaptation of the boiling process and about its suitability for different species and forms of lumber before its value and field of usefulness can be determined. It may be found more useful for special purposes than for the general drying of lumber.

Electrical Drying

There has been talk for 25 years or more about electrical methods of drying wood. It has been demonstrated repeatedly in this and other countries that water can be driven out of wood by suitable application of electric current. Recently, the emphasis has been on the use of high-frequency dielectric heating for the purpose. By this method the water in the wood can be made to boil quickly, and woods that resist the rapid passage of moisture can even be exploded by the steam pressure built up in them. The two factors that have thus far limited the use of high frequency for lumber drying are the cost of the apparatus and power required and the difficulty of controlling the process so as to give rapid drying without burning, checking, honeycombing, or exploding the wood. I do not know of any commercially successful use of high-frequency heating for the drying of wood, although it is finding increasing use in special applications of wood gluing.

High-vacuum drying of wood has also been promoted in a small way for many years but, so far as I know, without commercial success. Its effectiveness is necessarily limited by the difficulty of applying heat to wood in a vacuum and by the slowness with which moisture passes from the interior to the exterior surface of wood, particularly in resistant species.

Recently, drying wood by infra-red heating has received some attention, but its suitability for this purpose is not promising despite its usefulness for other purposes.

Air Drying Still Does the Job

In the face of all our knowledge of seasoning and of conditioning wood for preservative treatment, air drying still does the bulk of the job and will probably continue to do so for a long time to come, despite its shortcomings and limitations. Lumber, timbers, ties, poles, posts, and piles stacked for air drying are a familiar sight all over the country. Much of this material is properly piled for good drying and minimum deterioration. Much of it is less satisfactorily piled, however, and deterioration from warping, checking, and decay is more rapid than need be. I will not undertake to describe the rules of good piling because there are numerous publications that give information on the subject. Proper observance of these rules, however, and their application under special local conditions will well repay the effort.

One new factor in the air drying and storage of lumber is the increasing practice of handling lumber in packages, direct from the saw or planer. From the standpoint of efficient handling, the system saves labor and money where the volume handled is sufficient. Solid piling in packages, however, does not favor prompt or uniform drying, and if solid piles are left too long, there can be serious damage to the lumber through sapstain and decay. When stickers are used in the packages, however, good drying is favored. Treatment of the lumber with sapstain preventives before piling in packages reduces the danger of both stain and early decay, but does not provide indefinite immunity from either. The remedy is to use the wood, treat it, or put it through a good seasoning process without leaving it too long in solid piles. The length of time green lumber can be left in packages without damage will vary somewhat with the species, the method of piling, the locality, and the weather. No general rule can be given except "Don't wait too long."

In closing these sketchy comments, the principal thought I would like to leave with you is that you cannot afford to wait for new developments to solve your wood protection problems. Make use of them as they prove their worth but, for the most part, your success will depend upon continued study and application of known principles of good practice.

TREASURER'S REPORT

SEPTEMBER 1, 1947 TO AUGUST 31, 1948

Cash Balance — September 1, 1947		$ 971.56
RECEIPTS:		
Dues	$2,091.00	
Advertising	1,662.04	
Miscellaneous	111.50	3,864.54
Total Receipts		$4,836.10
DISBURSEMENTS:		
Salaries	$ 568.03	
Social Security and Withholding Taxes	98.52	
Stationery and Printing	1,932.51	
Postage	70.00	
Rent, Phone, Electric Light	247.65	
Bond Premiums	10.00	
Convention Expense (1947)	247.39	
Miscellaneous	170.41	3,344.51
Balance on hand August 31, 1948		$1,491.59
RECONCILIATION:		
Bank balance as of August 31, 1948		$1,491.59

L. C. WINKELHAUS,
Acting Treasurer.

SECRETARY'S REPORT

of

MEMBERSHIP FOR PERIOD ENDED SEPTEMBER 20, 1948

Active Members—September 15, 1947		430	
New Members since September 15, 1947		129	559
Reported deceased since September 15, 1947	9		
Resigned since September 15, 1947	11		
Dropped account non-payment of dues	68		
Transferred to Life Membership	15		103
Total Active Members — September 20, 1948			456
Associate Members — September 15, 1947		134	
New Associate Members since September 15, 1947		6	
		140	
Dropped account of non-payment of dues	28		
Resigned by letter	4		
Reported deceased since September 15, 1947	0	32	
Total Associate Members — September 20, 1948			108
Life Members — September 15, 1947		82	
Elected to Life Membership since September 15, 1947		15	
		97	
Transferred to Honorary Membership	1		
Reported deceased since September 15, 1947	5		
Dropped account mail returned and no forwarding address	6	12	
Total Life Members — September 20, 1948			85
Honorary Members — September 15, 1947		4	
Elected to Honorary Membership		1	
		5	
*Reported deceased since September 15, 1947		2	
Total Honorary Members — September 20, 1948			3
TOTAL MEMBERSHIP AS OF SEPTEMBER 20, 1948			652

*C. R. Knowles, Supt. W. S., I.C.R.R. (Retired) (1912)
F. L. Thompson, V.P., I.C.R.R. (Retired) (1908)

Eliminating Waste of Water

Report of Committee

E. R. Schlaf (chairman), asst. supt. w. s., I. C., Chicago; J. A. Jorlett (vice-chairman), mast. carp., P. R. R., Pittsburgh, Pa.; R. H. Morrison (vice-chairman), prin. asst. engr., B. & A., Houlton, Me.; A. H. Frisbie, fore. w. s., C. & N. W., Sioux City, Iowa; F. M. Ginter, w. s. fore., G. M. & O., Bloomington, Ill.; J. P. Hanley asst. supt. w. s. (retired), I. C., Chicago; B. J. Howay, supvr. b. & b. and w. s., C. & O., Grand Ledge, Mich ; W. H. McCollum, supvr. w. s., I. C., Paducah, Ky.; H. C. Meddles, div. w. s. fore., A. T. & S. F., Winslow, Ariz.; E. C. McFadden, Chicago dist. mgr., Pittsburgh Pipe Cleaner Co., Chicago; and C. A. Smith, supvr. b. & b., I. H. B., Hammond, Ind.

IT IS estimated that the annual cost of water for the Class 1 railways of the United States amounts to approximately $35,000,000, and that the annual cost of maintaining water stations is approximately $15,000,000. This large expense indicates that water is one of the most extensively used commodities by the railways and that careful and painstaking practice is justified in preventing even a small percentage of leakage and waste.

A large part of the water now used by the railroads for steam generating purposes is treated with lime, soda ash, or compounds, and the cost of this water is considerably greater than that for untreated water, which is an added reason for preventing water waste under present-day conditions. Water and air have been considered to be free and common-place for daily use. However, underground water levels are receding and surface supplies are becoming polluted, and both supplies are becoming more expensive to pump and condition. To a certain, but perhaps less noticeable, extent, our water reserves, like our timber and mineral reserves, have reached a point where conservation should be practiced in many localities.

Water Column Waste

Considerable water can be wasted by overflowing engine tenders. This can be eliminated by cooperation between water service men, engine foremen, trainmasters and track supervisors, working together to correct faulty conditions. Water service men should see to it that water columns are maintained to a high standard, that the water flow is at full capacity, and the valve closure effective and dependable; also that the grab irons, chains and operating parts handled by engine crews are in good operating condition. The interiors of column pits should be inspected frequently for leakage. The drains from the pits are concealed and potential leakage hazard exists between infrequent inspections. Engine foremen and trainmasters should impress engine crews with the understanding that tender overflow is expensive and unnecessary. In some cases the cost of treatment of water used for locomotives exceeds the cost of the water itself. Track supervisors should be alert to report offenders as the wasted water creates extra expense for maintaining track at water column locations.

The hydrants at cinder pits and for dispensing drinking water are often permitted to flow continuously when not in use for the purpose for which they were installed. In the case of the cinder pit hydrant the usual excuse is that it is done to prevent freezing. This condition could be corrected by enclosing the hydrant in a frost-proof box or by using a self-draining valve. Hoses should be fitted with quick couplings so they may be uncoupled and drained after each use. In some cases leaking cinder pit hydrants could be corrected by better maintenance and better cooperation between the water service man and the parties using the hydrant.

In the case of drinking water hydrants, which are often permitted to flow continuously, the reason usually given is that the flow is necessary to keep the water cool. Where such a condition prevails, the use of ice or electric coolers should be considered. In other cases continuous flow is used to neutralize the effect of tastes and odors in the water. In such cases consideration should be given to the use of bottled water, combined with coolers, as more economical and attractive than the natural supply. A type of natural water with limited amounts of iron can be conditioned satisfactorily by the use of coolers alone, and does not require continuous flow to improve color or taste.

Plumbing and Power Equipment

In large office buildings, shops, and power plants where a relatively large amount of plumbing fixtures, piping and valves exist for conveying water and steam, careful attention should be given to water consumption. In cases where congested plants exist, some responsible employee should be delegated to correct water and steam leaks. The power plant or building engineer, plumber or water service man should make inspections at suitable intervals for leaking fixtures, and should take a daily reading of the master meter supplying water to the premises at about the same time each working day. If these readings, when compared, indicate leakage or unusual use of water, the office in charge should make immediate investigation to discover and correct the cause of the increased registration. Municipal water departments usually render bills on a monthly basis, and if leaks or waste should start in the early part of the cycle, much valuable time may be lost before the increased water bill rudely awakens the customer to the knowledge that water leakage is indeed expensive when permitted to exist for any considerable period of time.

The unnecessary use of sprinking and wash-out hose around shops can also waste considerable water. Engine tenders filled on the inbound track are sometimes emptied on arrival in the house for cleaning and repairs. This practice may be corrected by a better understanding between the men handling the engines.

The automatic valves controlling the inlet of additional or cooling water into power-house heaters and enginehouse wash-out tanks should be inspected at suitable intervals to detect any leakage. The outlets and overflows from heaters and tanks should be of the visible type, with an air gap before entering the sewer, so that unusual overflow or waste can be readily observed.

The automatic valves and float switches controlling the high water level in roadside tanks should also be inspected and repaired on a schedule planned to prevent water overflow. Such overflow is wasteful in warm weather and both wasteful and unsightly when the overflow freezes. Tanks and supports can be so heavily covered with accumulated ice from this cause that the safe load factor may be exceeded and falling ice may become a hazard to people in the immediate vicinity.

Leakage in Underground Mains

The foregoing discussion has described surface and fairly visible conditions that can be corrected by routine inspections and reasonable diligence. However, the most troublesome and expensive water waste occurs in underground mains and supply pipes. If such leakage is suspected or known to exist, a great deal of checking with test meters, leak detectors and special survey work is indicated. An intensive survey should be carried out and repairs made to prevent leaks and waste that can be corrected without unreasonable expense. The balance of the unaccounted for loss of water may necessarily have to be tolerated as a lesser evil.

Undeground leaks are often expensive to repair when they occur in congested terminals where the mains are laid under tracks, switches and other structures. The grade at many terminals has been progressively raised over the years and water mains originally installed in a trench of moderate depth have, as a result, been further covered to excessive depth with various kinds of filled material often unsuitable for water pipe coverage. This condition, plus vibration from trains using nearby tracks, increases the tendency to leaks and also increases the expense of making repairs.

When leaks of this kind occur, it is suggested that the jointing material be renewed or solidly recalked, and, in addition, that a bell joint clamp be applied before backfilling. It has been found that the progressive applications of these clamps has stopped leaks of the repeating type which occurred at short intervals in the same joint due to vibration from trains or unfavorable soil conditions. Consideration should also be given to the application of joint clamps on new pipe lines when such lines are installed in locations where conditions may become unfavorable for the standard joint.

In cases where pitted or sub-standard sections of water mains are known or suspected to exist, such sections should be renewed with sound pipe rather than be allowed to remain, subject to repeated repairs. Taps in mains and service lines no longer used should be cut off and plugged at the main to prevent possible leakage between the main and the building for which the supply is no longer needed.

New Water Main Systems

In the installation of new water mains, consideration should be given to the installation of sub-meters for various areas of the premises so that individual sections of the system can be shut off and checked for leakage without disturbing other sections. In cases where sub-meters are considered too expensive, a liberal number of gate valves should be used on the laterals, and space should be provided for a portable test meter for temporary installation on each important lateral in order to permit future checks for leakage. This feature of design will avoid future expense and will make leak investigations much more convenient to handle. The advantage of the permanent sub-meters lies in the fact that frequent readings may be taken and the total compared with the master meter and with previous readings from the same sub-meter. These comparisons provide a quick method of locating the area showing unusual water consumption. At critical locations at terminals, which cannot be deprived of water, a temporary supply pipe should be installed while the permanent lines are being checked for leakage.

Sub-Surface Escape of Leakage

Considerable leakage occurs which does not appear on the ground surface. Many railway terminals have been raised with filling material. In such cases the fill is often porous and water seeps through it into ditches and tile drains without giving leak indications on the surface. In some locations sewers and drains have been laid in the same ditch with water pipes, and while this practice may reduce installation cost, it provides easy means for the invisible escape of leakage. A case of this kind is reported where long continued investigation was required to discover an underground leak. When finally located, it was found that a pit hole ¾ in. in diameter existed in a 6-in. water main, and that the water was escaping into a nearby sewer which had defective joints. The main and sewer were about two feet apart and the pressure leak had bored a well defined tunnel to the sewer without surface leak indications.

The flow in sewers should be observed in leak investigations at terminals. If approximate gaging of the flow at the outfall shows more discharge than could be expected from the water received, each sewer lateral should, in turn, be gaged at different times of peak and off-peak water discharge by the terminal. If the flow continues relatively large in one or more laterals and decreases and increases in other laterals, the leakage may be suspected to exist near the lateral with the more uniform large flow for the periods observed.

Detecting Leaks

The detection of underground leakage not appearing on the ground surface is assisted by the use of up-to-date equipment and methods. This equipment consists of ear phones, sounding rods, pipe finders and leak detectors. The methods used should start with a fairly accurate map showing the locations of the water mains and sewers at the terminal to be investigated. A calculation of the most favorable areas for hidden leakage should be made and tested. The pipe line location should then be definitely established and marked on the surface, after which the leak detector should be placed directly over the pipe and a listening test made at intervals of 20 ft. If leakage is occurring near these listening stations the leak sounds should be audible in the earphones. If definite results are not obtained in this manner, sounding rods may be driven into the ground until they contact the pipe, and listening tests made by placing the machine on the rods. Test holes may also be excavated at a few doubtful points along the pipe line to check the correct location, and at such points the leak detector should be placed directly on the pipe for an additional test. Progress of the work should be indicated on the map referred to, and the investigation conducted in an orderly manner without duplication or indefinite movements.

Publicity to Prevent Waste

The use of publicity to decrease and prevent water waste has been used extensively by the railways. The publicity is usually applied in a manner similar to that used in fuel saving campaigns and a certain month designated as "Water Saving Month," during which all employees are urged to save water. Posters are placed on bulletin boards and at other conspicuous locations. On these the large volume and expense of even small leaks is illustrated and set forth on a monthly and yearly basis. Water saving is discussed at meetings and employees are made aware that any savings made are highly worth while.

Publicity campaigns are responsible for considerable savings in the use of water, but, like other forms of advertising, they should be well planned and properly spaced so that the information conveyed will be interesting and the bulletins will not become commonplace. If the subject is not presented in an interesting manner, employees will drift back to the old habit of allowing water to run from the hose and faucet as the easiest way to prevent it from freezing and the most convenient method for providing cool drinking water.

Incrustation in Water Mains

The incrustation of the interior of water mains may well be considered in connection with the subject of water waste. It is true that incrustation may exist without the actual presence of leakage, but incrustation does increase the water pressure in a main under the same rate of flow, and increased pressure and water hammer increase the tendency for more and larger leaks. Incrustation increases the friction head and decreases pumping efficiency, both of which represents a decided operating loss in increased power bills and maintenance expense.

In many instances incrustation progresses in mains until the condition becomes critical and the mains can be cleaned by mechanical methods and restored to approximately 95 per cent of their original capacity. In the meantime, the gradual increase in incrustation may have caused relatively large operating losses, as well as incidental losses and inconvenience in plant operation by restricted supply and temporary delays.

Several contracting firms, with suitable equipment and trained personnel, specialize in water main cleaning, and are prepared to do this class of work more economically than new mains can be installed. The use of this service should be considered by railways when conditions indicate that the flow in any particular main shows unusual friction loss.

Conclusions

(1) Water is an extensively used commodity by the railways and represents large-scale expenditures. The reduction of leakage and unnecessary use, even by small percentages, should be urged on all employees. Above ground waste, such as overflowing engine tenders and water tanks, and loss through boiler feed heaters and washout tanks, is usually visible and can be corrected with a moderate amount of effort and expense.

(2) Water loss through underground leakage requires greater effort and expense. Persistence and ingenuity are required on the part of supervisors and workmen in locating and repairing many underground leaks. However, the saving in water bills will more than repay the extra effort and expense incurred in correcting underground leaks.

(3) The use of an orderly system in detecting leaks, and of modern equipment such as leak detectors, pipe-line locators, earphones and sounding rods, are recommended. The leak detection crew should be composed of persistent workers, and should be well instructed on how to proceed to the best advantage. It should be supplied with a fairly accurate map of the premises and pipe lines, and should mark progress on this map as the search progresses.

(4) In locations where incrustation in water mains is indicated, prompt investigation should be made to discover the actual friction loss, as this condition decreases pumping efficiency and increases power bills. Consideration should be given to cleaning the mains if the investigation indicates that the cost of this work is justified by the estimated savings.

Types of Bridges for Replacing Timber Trestles

Report of Committee

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AMERICAN railroads are today faced with excessively increased costs of operation and maintenance. Labor costs have increased a considerable amount and material costs have shown progressive increases, with totals now aggregating as much as double the costs of 10 years ago.

Wooden bridges and timber trestles for railroad use date back to the first railroad construction in the early 19th century. Steel has gradually replaced wooden bridges so that now we find only a few Howe trusses in use on light-traffic lines. However, the use of timber trestles still remains as standard on many American railroads.

In the preparation of this report a comprehensive study was made regarding the economy of construction, annual maintenance expense and replacement costs of timber trestles in use throughout the United States. These costs were then compared with similar costs of permanent or semi-permanent types of construction used for replacing timber trestles. More than 100 main-line railroads were asked by questionnaire to furnish data suitable for this study, and the answers received are summarized.

The prime purpose of this report is not only to suggest types of bridges for replacing timber trestles, but also to review possible savings for the railroads by decreasing maintenance costs through suitable and economical construction.

Cost of Timber Trestles

From data furnished by various railroads, the present average cost per lineal foot to replace single-track timber trestles, using creosoted piles, average height 10 ft., was found to be as shown in the accompanying table.

Variations from maximum to minimum result from cost of material differentials, density of traffic and methods of construction. However, it is interesting to note that, from the majority of roads reporting, the overall percentage increase in timber trestle replacement costs from 1938 to 1948 was an average of 142 per cent. Increased labor rates and decreased labor efficiency, together with large increases in

Cooper's Loading	*Open Deck* (Untreated deck)	*Ballast Deck* (Treated deck & bents)
E-40	$40 Min. to $65 Max.	
E-60	53 Min. to 70 Max.	$70 Min. to $100 Max.
E-72	60 Min. to 75 Max.	75 Min. to 105 Max.

material costs, are reflected in this increase.

Increased material costs are reflected in the following tabulation showing average reported costs.

Item	*Cost in 1938*	*Cost in 1948*
Untreated piling (lin. ft.)...........	$ .20	$ .45
Creosote piling (lin. ft.)...........	.53	.95
Select structural timber (m.b.m.)....	54.00	110.00
Other timber (m.b.m.)	28.00	71.00

Placing costs have increased in a larger proportion than increase in wages. This con be attributed, in part, to the fact that many railroads are no longer able to employ enough trained carpenters for trestle construction. This can only be corrected by adequately equipping present gangs with power tools for greater efficiency. Present-day framing and placing costs were reported at from $40 to $75 per MBM on an average, with several roads reporting framing and placing costs up to $160 per MBM.

Average annual maintenance costs for open-deck trestles have shown a definite increase. These costs were reported as a minimum of $1.00 to a maximum of $3.00 (per lineal foot of trestle). Ballast-deck trestles were reported to have a much lower average annual maintenance cost, varying from $0.10 minimum to a maximum of $1.50 per lineal foot of trestle.

In studying the service life of timber trestles, open-deck trestles were considered in component parts. The reported *average* service life of these parts is tabulated below:

	Untreated	*Treated*
(A) Ties	11 years	20 years
(B) Stringers ...	14 years	28 years
(C) Caps	12 years	20 years
(D) Bents	10 years	27 years
(E) Bulkheads ..	11 years	31 years

It will be noted from the above that, with normal open-deck trestle life, replacement of ties, stringers and caps can be expected before bent renewal. The number of deck replacements will vary depending upon whether treated or untreated, density of traffic and climate. With normal repairs, open-deck trestles have an expected service life of 20 to 25 years.

With treated ballast-deck trestles, service life for the entire structures were reported at from 35 to 40 years as an average. However, it was further reported that cap renewals could be expected within 25 to 30 years.

Timber Trestle Replacements

When a timber trestle reaches the end of its service life, comprehensive engineering and economic studies should be made to determine the most economical and suitable structure as a replacement. This comparative estimate will be based on an assumed life period for the timber trestle as against the life period of a permanent or semi-permanent structure. This estimate should give the following details:

(1) Estimated service life
(2) Cost of renewal or replacement
(3) Cost of maintaining traffic
(4) Total cost of structure
(5) Annual interest on total cost
(6) Annual maintenance cost
(7) Annual amortization cost
(8) Total annual cost
(9) Annual gain or loss by replacement.

In this type of conparison, use of permanent structures may appear uneconomical in comparison with timber-trestle replacements, except culvert and fill replacements, which will be discussed later. No doubt, timber trestle replacements with treated bents will be found to be more economical than permanent bridges and can be justified for use on branch lines where the life of the line is in question. However, on high-speed main lines where safety and continuity of service are essential, greater weight must be given to the value of a permanent or semi-permanent structure.

The majority of railroads reporting stated that fire hazard and damage to trestles by drift were important considerations in determining structure replacements for main lines. Several roads, however, justified the use of creosoted ballast-deck trestles on main lines and open-deck trestles on branch lines on the basis that such trestles are flexible and that the material can be salvaged in case of relocations of the lines.

Where short spans are not objectionable and culvert installations are impossible, the use of timber trestles will, no doubt, be used for some years to come by some railroads, even though first cost of construction may rise higher than at present.

All roads reported that, where changes in construction were considered, engineering data is obtained before making trestle replacements. Situation surveys, including drainage areas, expected flood run-off, and bridge areas of adjacent state highways and railroads, are made to determine the size of waterway required. Observations of field men are considered essential.

Elimination of Fire Hazards

The elimination of fire hazards on trestles was strongly stressed by all concerned. Annual maintenance costs included the scalping or removing of grass and brush from underneath trestles and the removal of drift at all times. Water barrels and sand boxes were considered impractical unless the structures are near habitation. Where trestles are being used, galvanized covering of the stringers and caps is recommended by some roads; also concrete firebreaks spaced a minimum of 350 ft. apart. Covering of the ties with metal or with an asphalt-asbestos coating and rock chips was reported to be satisfactory as a fire preventive.

In regards to comparative construction costs and future maintenance costs of timber trestles as against semi-permanent or permanent structures, a diversity of ideas was offered. The ratio of the cost of timber trestles to semi-permanent structures has decreased and will continue to do so. Where the life expectancy of a line is at least two cycles of service life of a treated structure, consideration should be given to permanent construction. One road stated that it is using permanent construction when the estimated cost of this construction is not over 150 per cent of treated trestle cost. Another stated that trestle replacements were recommended when repair costs amount to 15 per cent or more of total renewal cost.

Considerable stress was placed by the majority of the railroads on the possibility of reducing trestle openings to actual effective area of waterway required as determined by situation and drainage surveys. Where this waterway can be handled by a culvert or multiple culverts, the culvert installation and filling to standard roadbed section can often be accomplished at a cost comparable to trestle replacement costs. An analysis of these comparative costs is given in one of the accompanying tables.

Cost vs. Life Expectancy

In the cost comparison you will note the use of an open-deck trestle gives the required structure at a lower first cost. However, in comparing the life expectancy of the structures, a semi-permanent structure will provide a lower annual cost than an open-deck trestle.

The railroads reporting recommended many types of permanent or semi-permanent structures for timber trestle replacement. It is considered that any

Trestle Replacement—Single Track

ESTIMATE OF COST-ALTERNATE TYPES

	10-ft. Conc. Arch	*120-in. Multiple Metal Plate Pipe*	*45-ft. Open-Deck Creosote Trestle*
Effective area waterway	72.6 sq. ft.	78.5 sq. ft.	182 sq. ft.
Length of barrel	38 ft.	40 ft.	
Concrete in barrel	126 yd.		
Cost of concrete @ $30 yd	$3,780.00		
Cost of 120" dia. pipe F.O.B. factory		$1,721.00	
Freight, store expense, unloading, installing, use of tools, move gang	$ 449.73	$ 520.32	
Plus 10 per cent for contingencies	$ 422.97	$ 224.13	
First cost, exclusive of headwalls	$4,652.70	$2,465.45	$3,375.00
Filling 3 bents @ 40c yd	$ 501.40	$ 548.60	
Cost 2 portals 100 yd. conc. @ $30	$3,000.00	$3,000.00	
First cost installed comp.	$7,652.70	$5,465.45	$3,375.00
Life expenctancy for annual cost comparisons	75 years	60 years	30 years
Interest at 4 per cent on installed cost	$ 306.11	$ 218.62	$ 135.00
Annual maintenance (after 5 years)	....	....	$ 60.00
Annual amortization at 4 per cent	$ 17.83	$ 22.95	$ 60.18
Annual cost installed	$ 323.94	$ 241.57	$ 255.18

structure having an estimated service life from 50 to 75 years can be classified as a semi-permanent structure. Service life of over 75 years classifies such a structure as a permanent structure. It will not be possible to give the full details relative to these recommended types as each structure will vary in relation to actual stream crossing and engineering design. Furthermore, the actual cost per lineal foot will vary with job conditions and traffic intensity. However, it is interesting to note that many railroads reported that construction costs of permanent structures were being greatly reduced by careful studies of each job in regard to the elimination of falsework and standardization of similar jobs.

Concrete Trestles

Six railroads reported the use of reinforced concrete trestles on high-speed main lines. The type of structure and first cost were justified by the greater economy of maintenance, elimination of fire hazard and, in some cases, freedom from marine borer attack. In general, the construction consists of precast reinforced concrete piles, poured-in-place reinforced concrete caps, and precast reinforced concrete slab decks. One road reported a similar type of construction but used piling of spiral welded pipe filled with reinforced concrete. The pile length was a maximum of 90 ft. below cut-off. In the above cases these permanent structures were of the ballast-deck type and have required no further bridge maintenance. None has been in use long enough to obtain maximum service life, but this type of construction can be estimated to have a minimum service life of 75 to 80 years.

Steel Beam Stringers

A larger number of timber trestles have been replaced with I-beam or wide-flange steel beam stringers, with span lengths up to 50 feet. Various types of support have been used in this type structure, such as reinforced concrete piles, steel H-beam piling, steel pipe and steel tube piling, and reinforced concrete piers resting on rock or foundation piles. It was recommended that, with steel H-beam piling, the piles be encased in concrete from pier cap to 3 feet below ground line. With the above types of pile supports, caps have been either poured-in-place reinforced concrete or steel beams. Steel beam stringers will vary, depending upon length of span and rated loading. Both I-beam and wide-flanged beams are being used with further fabrication as to cover plates and cross frames as are necessary. One structure was constructed with built-up, wide-flange beams fabricated from steel plates by welding.

The average first cost of this type of construction cannot be arrived at except for individual structures, as there is too great a variance in span lengths, type of support and type of deck. The majority of structures of this type reported on the open deck type. However, several railroads reported the use of wrought iron or cerosoted timber floors for ballast decks on steel beam stringers. Annual maintenance of these structures will involve painting maintenance work on the steel and deck maintenance on open-deck structures.

An interesting and economical structure reported on consisted of steel stringers made from an obsolete steel truss. The top chords and end posts were cut to the length of the new openings and were placed on concrete abutments and piers. Deck plank for the ballast deck was creosoted lumber.

Another economical type of structure reported on for short spans consists of T-rails (90 lbs. per yd.) on pile-bent or concrete-pier supports. This type of construction was used for either open-deck or ballast-deck trestles. Bearing plates were installed on top of the timber caps. For longer spans light I-beams were used. In this case, however, steel I-beam caps on timber piles provided the support.

Steel Girders

Several railroads reported the installation of steel girders, both deck and through-girder construction, to eliminate timber trestles. These installations were found necessary as the short-span trestles were creating hazards due to the blocking of the streams with drift or to ice flow damage. The girders were designed for the particular Cooper's E rating on the line involved. Supports for these various girder spans were either reinforced concrete piers or concrete or steel pile bents. The cost per lineal foot of the girder replacements was considerably in excess of the cost to replace the trestles in kind. However, stream conditions indicated definitely that longer spans were required to handle flood or ice flows and still provide for safe, high speed train traffic without interruption. Fire hazards were greatly decreased, especially in the case of the ballast-deck girder spans. These installations will require a nominal amount of maintenance, such as steel bridge painting and deck maintenance on the open-deck spans. The use of treated ties on these open decks will definitely increase deck life and reduce maintenance. Girder construction on permanent supports will give an estimated service life of 50 to 75 years.

No railroad reported the installation of steel truss bridges to replace timber trestles, all truss installations being noted as replacements of older truss spans. Any recommendation covering steel bridge or steel girder installations can only be made after a very comprehensive engineering study has been made of the particular stream crossing involved. General rules for such installations, therefore, cannot be considered in this report.

Culvert and Fill Construction

In the construction of early railroads in the United States, it was found in many cases that timber trestle construction was more economical than the construction of high roadbed fills. This was due to the fact that timber trestle construction was then relatively cheap, while grading by hand or horse-powered equipment was relatively slow and expensive. Today we still find many timber trestles, especially on our western railroads, that are of greater length than required for stream flow.

With the continued increased cost for timber trestle construction, detailed engineering studies should be made before any trestle replacement in the above category is made. Modern grading equipment has proved its place in railroad construction—excavating, hauling and building roadbed sections at locations far distant from the cuts or borrow pits. Grading costs with such equipment are relatively reasonable and engineering studies often indicate that trestles can be replaced economically by culvert and fill construction.

All of the railroads asked to participate in this study were questioned concerning their experience in trestle replacement by culvert and fill construction. Various types of culverts have been used by all the roads.

Only a few roads reported the use of treated timber box culverts. Good service life from these installations were reported as being obtained in damp climates. and laminated creosoted box culverts were reported to be in good shape after a service life of 30 years. However, possible fire hazard and increased cost of materials and labor have considerably decreased their use.

Concrete Pipe Culverts

Concrete pipe culverts have proved very satisfactory in some situations. Extra-strength reinforced concrete culvert pipe, manufactured under specifications ASTM C-76-41, is obtainable throughout the United States. However, considerable care must be exercised in its installation, as a uniformly compacted foundation must be obtained before installation. Furthermore, the larger sizes of pipe will be found to be extremely heavy and will require a locomotive crane or similar equipment for placement. The service life of concrete pipe was reported at 40 to 60 years, or longer, if properly installed.

Corrugated metal culvert, both pipe or multiple-plate type, are available in all commercial sizes and gages. The majority of railroads reporting stated that corrugated metal culverts have been used for trestle replacements. They recommended that this type culvert be coated to increase its life. The service life for this type pipe was estimated at from 40 to 60 years. In the case of high fills, some installations were made with a somewhat larger culvert than required for drainage. As a result, when replacement is required in later years, a new pipe can be threaded into the old pipe at a nominal cost and without opening up the roadbed or tunneling.

Many cast-iron pipe culverts are reported in service and as having given remarkable service life. However, no new installations were reported, due possibly to increased relative costs.

Reinforced concrete box and arch culverts were reported to be very satisfactory, although somewhat expensive due to increased labor and material costs. The service life of such culverts can be expected to be at least 60 years, providing good workmanship and materials are employed in their construction.

Conclusions

In considering the types of bridges for replacing timber trestles no fixed rule or standard can be given. Each situation must be studied in line with traffic requirements, safety of operation, replacement cost and annual maintenance costs.

On light-traffic lines timber trestles have been economical and have proved satisfactory for their many years of service life. Where safety of operation and traffic continuity on high-speed lines are essential, permanent or semi-permanent construction should be given preference for replacements of timber trestles. Many types of permanent or semi-permanent construction are available for such replacements. Careful study often indicates possible replacement without traffic interference.

Annual maintenance costs on railroad structures aggregate many millions of dollars. Realization of this fact will tend to force the replacement of temporary construction, which requires so large a part of this continuing maintenance cost. Money spent in improving American railroads is money invested in America's future.

Recent Developments in Fuel Oil Storage and Servicing Facilities

Report of Committee

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IT WAS reported to this association in 1946 that there had been a steady increase in the use of Diesel locomotives since the first streamlined Diesel-drawn passenger train went into regular service in 1934. In the two years since that report was made the total number of Diesel locomotives in service on the railways of the United States has increased 68 per cent and some individual classes have more than doubled in number. The accompanying table shows the changes that have occurred.

DIESEL LOCOMOTIVES IN SERVICE

	Feb. 1, 1946		May 1, 1948	
	Loco.	*Units*	*Loco.*	*Units*
Passenger	213	378	628	1,105
Freight	318	1,016	870	2,236
Pass. or Freight	89	126	65	101
Switching	2,373	2,383	3,069	3,087
Total	2,993	3,903	4,652	6,529

As can be seen from the table, the greatest percentage increase has occurred in road locomotives, both passenger and freight. The precipitous rise in the number of Diesel road locomotives has brought about a serious problem in the storage and handling of fuel oil. When the rapid increase in the number of locomotives is considered in the light of threatened, if not actual, shortages of fuel oil, there will be little doubt as to the seriousness of the problem of providing adequate storage capacities and facilities. Few railway planners could possibly foresee increasing requirements. Those that anticipated the expanding use of fuel oil relied on adequate distribution methods to provide for their needs. Recent experiences have shown that such reliance has not always been justified.

A typical example of how the need for storage facilities has expanded is provided by a relatively large Class I railroad which, only eight years ago, had only six two-unit Diesel locomotives. To service these locomotives six fuel-oil stations were installed, each embodying two storage tanks of 20,000 gal. capacity apiece. A motor-operated pump, having a capacity of 100 g.p.m., was used for transferring oil from tank cars to the storage tanks and from the latter to the locomotive fuel tanks. Emphasis was placed on the cleanliness of the oil as it was delivered to the locomotives. The precautions taken to insure that cleanliness included nothing more than screens located at both inlets in the top of each tank and in the outlet at the bottom of the tank, and a three-inch strainer or filter of the basket type installed in the discharge line adjacent to the pump. In addition, the hose nozzle, when not in use, was closed with a cap to prevent the entrance of foreign matter.

Consider the situation on that railway today. It now has 71 Diesel passenger units, 148 freight units, and 108 switchers. An additional 85 units either have been recently received or are on order.

Storage capacity has grown from a total of 120,000 gal. in 1940 to 2,100,000 gal. at 25 locations in 1946. At that time the total monthly consumption approximated 4,971,000 gal. Thus, since the storage capacity was a little less than two weeks' requirements, a burden was placed on the existing facilities.

New storage tanks are now being built at 18 different locations, varying in size from 20,000 gal. to 1,000,000 gal. Upon completion the oil storage will range from the minimum of 8,000 gal. to 2,030,000 gal. at the point of largest storage. There will then be a combined capacity at 43 locations of 7,160,000 gal., which will supply almost two months' requirements at the present rate of use.

Such rapid expansion as this paralleled on many other roads, has brought with it many different schemes suited to the individual needs and standards of each road or sometimes to each location. However, out of the many new installations being made throughout the country, a general plan is gradually crystallizing which represents a composite of the ideas of the many designers.

Facilities Generally Included

In this plan the total capacity of bulk storage to be provided is largely determined by consumption and space requirements. Usually it varies between the minimum of a week's supply to the maximum of three months' requirements. The total storage is seldom carried in a single tank unless the quantity is small. Multiple tanks provide a more feasible and uniform supply without conflicting with pumping operations during periods when cleaning and maintenance work is being carried out. The minimum size of individual tanks is usually 10,000 gal. The maximum size is an individual problem dependent on local conditions, and is steadily going up.

Tanks may be located above or below ground, the governing factors generally being local fire codes and available space. Where possible, above-ground tanks are preferred for the following reasons: (1) Accessibility for inspection and repair of the exteriors; (2) accessibility for draining condensate and sludge from the bottoms of the tanks; and (3) exclusion of water that may otherwise enter through undiscovered underground leaks.

Above-ground tanks, up to 25,000 gal. in capacity, are usually supported horizontally in concrete cradles. Those tanks having capacities in excess of 25,000 gal. are of the vertical type supported on a foundation of crushed rock or sand, usually mixed with oil and retained around the periphery of the tank by a small concrete wall.

Above-ground tanks are made to conform in strength to the American-Petroleum-Institute (A. P. I.) specifications, and to conform in most other respects to the requirements of local fire codes or, in their absence, to the requirements of the National Board of Fire Underwriters. Dikes are always specified by these latter authorities and vary in retention volume from 100 to 150 per cent of the tank capacity. The construction of the dike may vary from economical earth barriers to expensive concrete retaining walls.

The manner of transferring the oil from tank cars to storage tanks varies on individual roads. Most of them prefer, however, to pump the oil through the domes of the tank cars for two reasons: (1) Sediment collects in the bottoms of the cars and drains off with the oil when it is transferred through the bottom openings; and (2) the spillage that results from making connections to the tank bottom is wasteful and creates a fire hazard.

Unloading racks in most cases are similar to those used for many years by oil companies except the few instances were aluminium drop pipes have been used for lightness and to reduce the hazard of sparks made by iron pipes striking the tank cars. The average arrangement of pumping and servicing facilities can be shown best by giving a brief description of two recently completed installations, one typical of the methods employed in warm territories and the other of those used in cold areas.

Typical Southern Installation

In the southern installation, oil cars are unloaded at a five-position dome-unloading station. The transfer of oil to the storage tanks, which have a combined capacity of 120,000 gal., is effected by a 200-g.p.m. rotary pump, housed in a 16-ft. by 16-ft. concrete-block pumphouse. A similar pump, also located in the pumphouse, transfers oil from the main storage tanks to two 5,000-gal. delivery tanks located at the main-track fuel stations.

When the liquid level drops in either of the delivery tanks while a locomotive is being fueled, a float switch starts the pump at the main pumphouse to transfer oil from storage. When one tank becomes full, a float valve prevents it from overflowing while the other is being filled. Pumping continues until both tanks are full.

The piping in the pumphouse is arranged in such a manner that, if necessary, each pump may be used interchangeably. For each pump there is a pipe-line strainer, an air-release tank and an expendable cartridge filter. Pressure valves are installed on each side of the filter so that the progressive clogging of the filters may be watched and the cartridges changed accordingly.

In being transferred from the unloading point to the pumphouse, the fuel oil passes through a 6-in. wrought-iron line, laid in a concrete trench. Elsewhere the line is overhead except where it extends under the tracks, enclosed in a 14-in. cast iron pipe conduit, or where it by-passes the station area, being carried underground in a 15-in. insulating conduit. The overhead sections of the line are carried on rollers attached to steel-pipe brackets welded to posts made of scrap rail set in concrete.

Two refueling stations — one for trains in each direction—are so located that three-unit locomotives can be serviced while the station stop is made. Each fueling station consists of a concrete platform 10 ft. wide and 220 ft. long, along the center of which five fuel-oil columns are located so as to serve the fuel tanks of various locomotives. Water servicing facilities are also provided.

Oil is pumped from the 5,000-gal. delivery tanks by a 500-g.p.m. pump driven by a 10-hp. electric motor which is housed in a 7-ft. by 7-ft. concrete-block pumphouse. The operation of the pump is remotely controlled from the fueling platform by a push button.

The fuel-oil columns, of the swing-pipe or "boom" type, are made of 4-in. wrought-iron pipe and rise to a hegiht of 9 ft. 11 in. above the platform. An 8-ft. length of 2½-in. hose is attached to the end of the boom by a single-swing elbow. At the end of each hose is a 2½-in. fuel nozzle, which may be opened and closed quickly by hand, and a quick-assembly connection for attaching the hose to the fuel tanks.

Typical Northern Installation

The northern installation is typical of several that have been constructed recently where extremely cold weather can be expected. These particular fueling stations are located so that only trains in one direction are fueled at each station, and individual storage capacity is thus reduced below the average.

One or two tanks, each with a capacity of 25,000 gal., are provided at each station. They may be above or below ground, depending on local conditions. The above-ground tanks are protected with two-inch secondhand boiler insulation which is covered with sheet steel from old locomotives and painted with aluminum paint. The tanks rest on steel saddles supported on concrete pedestals. The tanks tip slightly toward the end having an outlet drain. Steam pipe coils are provided within the tank to keep the oil warm enough to be pumped and filtered easily. Steam in the coils is regulated by a thermostatic valve. This conforms to the recommendations of the oil industry that provisions be made to heat fuel oil in territories where the temperature may fall below 0 deg. F. The tanks are provided with gauges, manholes, vents and inside ladders and are designed to conform to the specifications of underwriters whose label they bear. Each tank is grounded to permanent moisture and is diked.

To unload a tank car at such installations it is emptied through the dome at an unloading rack of which the horizontal and downspout portions are made of light 4-in. tubing to facilitate handling them in and out of the car. The principal equipment is installed in an insulated, prefabricated, steel building, which is heated by steam pipe coils.

The piping arrangement in the pumphouse is such that the oil coming from the tank car first passes through a strainer then through either of two 250 g.p.m. rotary pumps connected in parallel, thence through an air release tank, two filters, and a meter to the storage tank. In pumping oil from storage to a locomotive, both pumps are used. In this operation the oil from the pumps again goes through the same air release tank, and two filters, but through two different meters to three platform delivery hose pits. It has been found more economical to provide the two 3-in. meters in the fueling line than to install a single meter capable of registering 500 g.p.m.

The platform hose pits, placed to conform to fueling inlets on locomotives, are made of concrete, with hinged, steel-plate covers. Each pit has steam coils to keep the oil lines warm in winter and each contains a reel on which 25 ft. of 2½-in. hose is wound. These reels are operated by brake wheel cranks and a pinion gear shaft. The cranks are hung in the pits when not in use. The end of each hose hangs on a hook just inside its pit cover when not in use. Remote control push buttons are provided at the oil delivery pits to start and stop the pumps. Special lighting facilities are installed for night operation. All undeground pipe lines are coated with an application of asphalt and burlap.

Fire Protection

Neither of these two examples includes any fire protection facilities other than the grounding of storage tanks. Fire protection systems constitute one of the most recent and most rapidly expanding new developments in fuel-oil installations. Such protection may begin by bonding and grounding the track on which the tank cars are unloaded. Most but not all roads do this. Those that do not, justify their actions by the fact that Diesel fuel oil is a class III liquid, having a flash point higher than 70 deg. F. Under most codes, tracks are not required to be bonded where only class III liquids are unloaded. Where tracks are bonded, it is usual that storage tanks and pipe lines are grounded to "permanent moisture." Practically all tanks are provided with screened vents approved by fire underwriters.

There is a growing tendency among railways to provide additional fire-fighting apparatus to safeguard adjacent property against the spread of any fire which may start in fuel-oil-storage areas. In some installations dry-pipe foam systems are installed with small fire houses located some distance from the danger area. At other places automatic fog-nozzle systems have been installed where adequate water pressure is available. Often both of these systems are combined.

All insurance-company engineers insist that there are fire hazards in varying degree in connection with the handling of Diesel fuel oil from the time it is received on the unloading track until it is delivered into the tanks of locomotives. The chief engineer of one insurance company doing a large railway business was asked for suggestions as to how fuel-oil facilities should be protected. He said that, first of all, "no-smoking" and "no-open-flame" signs should be posted.

In addition he offered the following suggestions: "Fire protection for such facilities should consist of a conveniently located 20-lb. carbon-dioxide extinguisher, or an equivalent size of an approved dry-powder type for the smaller installations, and additional protection where the installations are large enough to justify it.

"A few construction and installation features have a direct bearing on the hazard of fire. A fuel-oil pumphouse should be of fire-resistive construction and be provided with explosion-proof electrical installations. Care should be taken to see that a check valve is installed in the pipe between the unloading rack and the first valve at the pump, and another check valve installed between the filter, or the equalizing pressure tank, and the storage facilities. These valves are necessary to prevent a back-flow of oil through the pumps in case the manually-operated valves are accidentally left open.

"In some cases gasoline-driven standby engines are provided for service in case of power failure and the resultant immobility of the electric-driven, fuel-oil pumps. Where such gasoline engines are provided, they should be installed in a separate room cut off from the fuel-oil pumphouse proper by a fire wall. The shaft from the gasoline engine to the fuel-oil pump, which of necessity must run through the fire wall, should be equipped with a stuffing box.

"Diesel fuel-oil storage tanks of 100,000 gal. or larger capacity should be installed where they will not expose other property and should be diked separately. A drain pipe having a valve should be placed in the dike so that any water accumulations in the enclosed space may be drained easily.

"An automatic built-in foam-generating system should be installed as fire protection at each Diesel fuel-oil storage tank having a capacity of 100,000 gal. or more. When such tanks or other facilities are located where yard hydrants are available at which pressures above 45 lb. at the nozzle can be secured, each hose house should be equipped with an approved fog nozzle.

"Diesel fuel-oil piping should be welded at all connections possible. The trend is to install such pipes on permanent non-combustible supports above ground so that in case any leak develops it can be quickly detected. In some of the earlier piping installations screw joints were used, and in a few cases serious leaks developed even though the joints were coated with a mixture of Venice turpentine, litharge and shellac, or a mixture of litharge and glycerine. It has been found generally that Diesel fuel oil will seep through any connection except a welded joint."

Probably the most recent development in Diesel fuel-oil storage-tank protection is the automatic fog and fog-foam combination. In this system hydraulic arms are arranged so as to move out over the tank when the temperature reaches a predetermined figure. At the outer end of the arm a rotary fog nozzle is attached which will deliver 200-g.p.m. for a 40-ft. diameter coverage. The valve mechanism and water-flow control is located below frost line in a closed galvanized case. Full provision for drainage is provided. For tanks more than 40-ft. in diameter a manually-operated foam system is usually added. In this system, water fog first cools the material and then mechanical foam is used through the same nozzles that were utilized for dispensing the fog.

One road, recognizing the hazard of fire caused by oil being spilled at main track fueling stations, has installed a method of collecting the spilled oil. This consists of a concrete apron under the track, and a drainage ditch along one side to collect the oil and carry it to a catch basin. From the catch basin the oil flows to a settling basin and thence to a proprietary interceptor and separator. From this device the water is drained into a sewer and the oil is pumped into drums. The installations now in service are rated at 200 g.p.m. but will take an occasional flow of 1000 g.p.m. Such a system, complete with pumps, valves, electric panel-board and other fittings is said to cost about $2,500.

While railway fuel-oil storage facilities have been expanding rapidly, the oil companies have been continuing their research and experiments to improve their facilities and those of their customers. One of the most significant developments of their research work has been that pertaining to corrosion of oil facilities, particularly tanks.

The replacement or reconditioning of oil-storage tank bottoms due to external corrosion has been an expensive maintenance item to the oil industry. The annual loss, from this source, to the nation's pipe lines and storage tanks has been estimated at $200,000,000.

After a study of various methods of minimizing this loss, several oil companies have resorted to the universal use of cathodic protection. In one installation a number of 20,000-bbl. tanks was protected at a cost of about $300 each. Around each tank 12 holes 7 feet deep were drilled by hand augers about 2½ ft. from the tank and about 17½ ft. apart. Magnesium anodes weighing 60 lb. apiece were placed in the holes and surrounded with a wet backfill consisting of 75 per cent bentonite and 25 per cent gypsum. The anode leads were bolted to the angle irons at the base of the tanks. Electrical measurements which have been taken indicate that such a system offers adequate corrosion protection, and it is estimated that the anodes will last for 15 years.

Sludge Elimination

Another development of significance to the railway users of fuel oil is a method of solving the sludge problem in oil storage tanks. According to good authority, such sludge is a water-in-oil emulsion in which minute globules of water are completely covered with oil. Sludge forms from the condensation of moisture on the inside of the tanks and then causes a great deal of trouble in filters, and, if not removed, in the injector nozzles of Diesel engines.

One of the reported solutions to this problem is to pour certain chemical additives into the oil storage tanks in small quantities. These additives are said to disolve the sludge already present in the tank and equipment and to prevent new deposits. Its proponents insist that these chemicals keep the entire system clean, from tank top to injector nozzles, and eliminate the job of cleaning tanks frequently. If such be true, the use of such chemical additives may well be considered by railway users of fuel oil. This is particularly pertinent in those instances where storage capacities are large and oil is stored for long periods.

DISCUSSION

President Hancock inquired if any roads were providing drainage through the dikes around storage tanks to carry off storm water. W. D. Gibson (C. B. & Q.) replied that this practice is contrary to law in many states. H. B. Christianson (C. M. St. P. & P.), in speaking of the importance of collecting spilled oil, told of the experience of one road, on which, over a period of years, a large quantity of oil spilled at a fueling point had saturated the surrounding ground. When pumped out, the accumulated oil totaled more than 9,000 gal. E. H. Barnhart (B. & O.) told of a similar experience in which spilled oil found its way into a city sewage system, and, through it, to a disposal plant, with harmful effects on the latter.

L. C. Winkelhaus, (C. & N. W.) questioned the practice, at fueling stations, of winding hose lines on reels when they are full of oil. Chairman Michael and others responded that this practice is followed at a number of locations with success. Another question by Mr. Winkelhaus dealt with the need for heating fuel oil during cold weather. Mr. Michael, in reply, stated that this oil, as furnished, has a pour point of 0 deg. F. and that failure to heat it may result in harmful effects to pumps and filters and to locomotives, possibly resulting in road failures.

Good Housekeeping to Promote Safety and Fire Prevention

Report of Committee

H. E. Skinner (chairman), supvr. scales and wk. equip., E. J. & E., East Joliet, Ill.; R. F. Spofford (vice-chairman), asst. div. engr., B. & M., Dover, N. H.; E. H. Blewer, (vice-chairman), supvr. safety engr., N. Y. C., New York; R. D. Bisbee, gen. fore. b. & b., A. T. & S. F., Dodge City, Kan.; S. L. Chapin, safety supvr, S. P., San Francisco, Cal.; H. D. Curie, mast. carp., B. & O., Garrett, Ind.; V. E. Engman, ch. carp., C. M. St. P. & P., Savanna, Ill.; R. Gunderson, supvr., b. & b., Sou., Valdosta, Ga.; R. L. Hecker, asst. b. & b. supvr., C. & O., Saginaw, Mich.; C. A. Hughes, supvr. b. & b., E. J. & E., Joliet, Ill.; F. W. Hutcheson, supvr. b. & b., C. & O., Newport News, Va.; V. W. Hutchings, supvr. b. & b. S. P., Bakersfield, Cal.; H. G. Johnson, asst. engr., C. M. St. P. & P., Ottumwa, Iowa; L. R. Morgan, fire prev. engr., N. Y. C., Detroit, Mich.; W. H. Pryor, gen. fore. b. & b., St. L.-S. F., Memphis, Tenn.; T. H. Rainey, asst. supvr. b. & b., T. & N. O., San Antonio, Tex.; Geo. W. Rear, Jr., asst. gen. fire insp., S. P., San Francisco, Cal.; A. G. Reese, dist. maint. engr., C. B. & Q., Galesburg, Ill.; B. C. Smart, supvr. m. of w., D. T. & I., Dearborn, Mich.; H. Von Schrenk, consult. timber engr., N. Y. C., St. Louis, Mo.; B. M. Whitehouse, ch. fire insp., C. & N. W., Chicago; and N. H. Williams, b. & b. supvr., D. & H., Oneonta, N. Y

DURING the first eleven months of 1947 accidents resulted in injuries (with more than three days disability) to 32,642 employees of our nation's railroads, and death to a total of 632. Although this is a reduction of 7 per cent in injuries and a 4 per cent decrease in deaths compared with those in 1946, the figures are appalling and are an indication that accident prevention programs are still in their infancy on the railroads.

What corrective measures must be taken before we can erase these figures from the records and stop the suffering and loss of life involved? What are the costs of these accidents to the railroads and employees in medical expenses, wage losses, increased insurance rates, and so-called indirect losses? There are many answers to these questions, but one of the most important—in preventing accidents and their resulting costs—is "good housekeeping."

For the purpose of this report, good housekeeping may be defined as cleanliness, neatness and order as applied to buildings, locker rooms, shops and field jobs, so as to reduce or eliminate the hazard of personal injury, property damage or fire. Good housekeeping is, in itself, largely a matter of attention to details and alertness to detect potential hazards. The best efforts of the numerically few persons assigned directly to this work are much less effective than a proper interest on the part of supervisors, foremen and other employees.

A Fundamental Requisite

A fundamental requisite of any successful safety and fire prevention program is good housekeeping. Primarily, this is management's problem, for good housekeeping and orderliness are fundamentals of good management. Employees, however, must also do their part toward keeping their work places clean and orderly.

First, let us consider this matter as it applies to operations under the direct control of the bridge and building department, and then as it relates to other departments, bridge and building operations being sharply divided between those in their own shops, locker rooms and boarding car outfits, and those in the field or in buildings used by other departments.

In many instances, railway facilities, including buildings, are antiquated. That such is the case, with its influence on accident hazards, is beyond the consideration of this report. So far as this committee is concerned, we must consider that it is necessary largely to do the best we can with what we have, rather than recommend large expenditures for replacement. We must consider what we, ourselves, can do to promote safe conditions, without capital expenditures or special authorizations.

Immediate action on the part of the supervisor, with the means available at the time and place, shows his men that he is actively interested in their welfare. For example, tool racks can be improvised during inclement weather when the men would otherwise be idle. Steel lockers are inexpensive and can generally be obtained if the matter is properly presented to those in authority. Metal bins for oily waste, and bins for the collection of chips, shavings and sawdust in carpenter shops, can be improvised at little expense and with great benefit in preventing accidents and fires.

Storage of Materials

A frequently neglected feature is the proper storage of material and supplies. This is a source not only of accidents and fires, but of large wastages of material. Men working about or over poorly stacked material are not only hazarding injury but are wasting time needed for productive work. The provision of racks and bins for all material not only puts this material out of the way, so that injuries are avoided, but also makes it possible to get out material for a job with much less hazard of injury and with a large saving of time.

An added benefit, which should be attractive to management, is that, with properly arranged and marked racks and bins, a foreman can, with little effort, insure that he will always have on hand the material necessary for his work. At the same time it permits the supervisor and representative of the stores department to make sure that excessive amounts of material are not kept on hand, with consequent economic loss.

In field operations, the job of housekeeping should start as soon as the men arrive at the scene of their work. Bridge and building material should be kept neatly piled and sorted, both on the ground and in work cars. Methods must be worked out for the proper handling, placing, piling and storage of materials, with careful consideration to the volume and location. Men are constantly being injured by tripping over loose objects or slipping on greasy or dirty floors; by falling material and tools not properly placed; by running against poorly piled materials; and by hundreds of hidden causes which are the result of poor housekeeping.

Within and around buildings used by other departments, the responsibility of the bridge and building department is ordinarily confined to the maintenance of existing facilities and the construction of new facilities under budget authority. However, a cooperative attitude on the part of B. & B. employees will greatly assist those responsible for operation of the facility. Our assistance in the good housekeeping efforts of other departments not only helps to reduce loss and expense to the railroad as a whole, but frequently reduces demands on our department for repairs or construction.

To this point in our report we have dealt with the subject of good housekeeping and its relationship to the safety of the individual. This subject, however, has another relationship, which is equally important to the railroads and their employees, and that is the matter of fire prevention. Fire prevention involves not only protection from injuries to the employee, but protection for their places of work.

During 1947, 249 railroads in the United States and Canada, representing 266,000 mi. of first main tracks, reported the following number of fires and their causes and losses:

529 fires caused by sparks, hot coals or burning oil drip, with losses of	$313,693
87 fires caused by brake shoe sparks, with losses of	71,951
278 fires, caused by coal or wood stoves, with losses of	216,706
419 fires caused by smoking and matches with losses of	382,937
211 spontaneous fires, with losses of	198,577

How many injuries and how much damage was caused by all fires, and how many fires were the result of poor housekeeping, we do not know—but we do know that the maintenance of a high standard of cleanliness and order is perhaps the most important single element in fire prevention. Rubbish may not be the cause of a fire itself, but it supplies the fuel for a carelessly discarded match, cigarette or stray spark. Even when fire is attributed to some other specific cause, poor housekeeping provides extra fuel for the blaze and adds to the damage.

Locker Maintenance

The lack of cleanliness in lockers, and their general use as a storeroom for waste material, are fire hazards. This is particularly true when such lockers include waste, oily rags and clothes, or clothes smeared with paint. The use of cotton waste is very common, and the practice of storing small quantities, even though clean, in cupboards and lockers, is a fire hazard, as inevitably more or less dirty waste will be mixed with it. Where not removed from the building immediately, waste paper and other waste materials must be kept in fire-resistant containers. Any source of heat is a potential fire hazard to be guarded against by preventing adjacent combustible materials from reaching dangerous temperatures.

In many cases lockers are old and built of combustible material. If possible these lockers should be replaced with steel lockers. The tops of lockers should be slanted to prevent piling material on them. Lockers should fit tight to the floor so that material cannot be put under them. If new lockers cannot be obtained, there are almost always ways to improve existing conditions with slight expense. The provision of tables for men to eat their lunch, and properly located trash cans, will help in preventing accumulations of paper, and particularly of food particles that attract vermin. The most important requirement for locker rooms is to place definite responsibility for its condition on one individual, and give him the necessary authority to see that the room is properly used.

Housekeeping About Exteriors

Most of us are familiar with the requirements of good housekeeping within buildings and, perhaps, in stressing the necessity for cleanliness within, we lose sight of the requirements of good housekeeping about the exterior and surroundings, which are equally important. Water tanks, stock yards, trestles, ice houses, snow sheds, team tracks and isolated buildings are often neglected when it comes to good housekeeping. The decks of bridges are often sadly neglected. Waste rags, paper and other debris often become lodged in them and, when dry, are vulnerable to ignition from engine sparks or hot coals and burning oil drip. Dry vegetation is extremely hazardous, and housekeeping should include the removal of it from around and underneath cumbustible structures, including bridges and pole lines. Cleaning up of the site after completing a job is an important feature frequently neglected. Accumulations of scrap materials, even if not a hazard to the crew on the job, are a definite hazard of fire or accident to others.

Bad housekeeping promotes spontaneous combustion when substances subject to rapid oxidation are involved. Every combustible substance will ignite and burn if raised to a suitable temperature in the presence of air. Fire prevention practice starts, therefore, with the basic principle of preventing combustibles from reaching ignition temperatures—and by good housekeeping we eliminate these hazards.

Awards Recommended

The element of competition is frequently of great benefit when it is desired to engage the interest of employees in achieving a goal. This committee therefore, recommends that consideration be given to the making of awards for good housekeeping as applied to the physical property within the territory of each foreman or supervisor. Such a system would, however, be so varied from railroad to railroad, or from department to department, as to make it difficult to set up any standard form. If undertaken, it should be with the understanding that considerable effort will be required of supervisory officers, and that a definite attitude favorable to correcting and improving conditions will be assumed on the part of the management.

Without such an elaborate set up, benefits can be obtained only by special interest on the part of all supervisory officers. They should mete out guidance, suggestions and commendation to those doing exemplary work, and sharp discipline for those foremen and men who will not cooperate.

Planned Program Necessary

Good housekeeping is more than cleanliness; it is cleanliness and order. It cannot be had by an occasional grand clean-up, but must involve a planned program for each day's work. Every employee must do his part, as one poor housekeeper in an organization not only leaves much disorder in his path, but sets an example, disruptive to the morale of all.

A clean shop, office, warehouse, yard or right-of-way does more than merely impress the public; it prevents accidents and saves lives. To maintain such conditions requires the constant vigilance of all.

DISCUSSION

President Hancock started the discussion by requesting information relative to the issuance of awards as incentives for good performance. G. S. Crites (B. & O. retired) outlined a practice formerly used on the Southern Pacific wherein medals were awarded in connection with annual inspections of the various supervisory territories of the road. Mr. Crites also emphasized the great loss suffered by the railroads because of the careless habits of smokers.

F. M. Misch (S. P.) advised that awards were no longer made on his road, but said that much was accomplished by personal commendations of supervisory officers for meritorious work. He also stated that the site at each job should be cleaned up daily instead of waiting until the work is completed.

L. R. Morgan (N. Y. C.) commenting on fire protection for camp cars, indicated that calcium chloride, carbon tetrachloride and carbon dioxide fire extinguishers were in general use. He said that the 5-gal. pump-type carbon tetrachloride extinguisher is well suited for use in kitchen cars where oil and grease fires predominate. This type generally is also easier to recharge, he said. C. E. Gracelon (Bang. & Aroos.) commented on the valuable first-hand information he received by accompanying the fire insurance inspector on a trip over his road.

Enlarging and Relining Tunnels for Present-Day Traffic

Report of Committee

C. M. Eichenlaub (chairman), res. engr., S. D. & A. E., San Diego, Cal.; W. R. Harman (vice-chairman), supvr., b. & b., S. P., San Francisco, Cal.; R. W. Humphreys (vice-chairman), asst. b. & b. supvr., N. P., Missoula, Mont.; W. A. Batey, constr. engr., U. P., Omaha, Neb.; M. Coburn, Indianapolis, Ind.; C. M. Colvin, constr. supt., Armco Drainage & Metal Products, Inc., Berkeley, Cal.; M. H. Dick, managing editor, *Railway Engineering and Maintenance*, Chicago; J. E. Heck, supvr. b. & b., C. & O., Ashland, Ky.; B. Hemstad, mast. carp., G. N. Willmar, Minn.; B. D. Keatts, reg. v. p., Intrusion Prepakt, Inc., Cleveland, Ohio; T. J. Martin, gen. mast. carp., G. N., Seattle, Wash.; M. Montgomery, dist. mgr., Master Builders, Los Angeles, Cal.; G. W. Morrow, sales mgr. r. r. div., Worthington Pump & Machinery Corp., Chicago; G. H. Paris, r. r. repr., Portland Cement Association, Chicago; A. O. Ridgway, engr. consult., D. & R. G. W., Denver, Colo.; W. R. Roof, br. engr., C. G. W., Chicago; and O. W. Stephens, asst. engr., struct., D. & H., Albany, N. Y.

IN THE enlarging and relining of tunnels, a large number of conditions are encountered, each of which requires careful study to provide the proper construction methods and materials.

In general, the Southern Pacific has adopted a "Rib Design" for enlarging and lining tunnels under traffic. Large sections of this design have been installed on the Cascade line and on a number of the other divisions. This procedure has proved to be both economical and sufficient for the purpose.

By this method the enlargement is completed with desired clearance at the face of the timber sets, the space between the sets being filled with reinforced concrete. The timber sets may then, at some future time, be removed and their voids filled with reinforced concrete to complete a continuous concrete lining. This permits obtaining the desired clearance with less excavation than by the old method of placing the lining in front of the posts. Where pressure has required a heavier lining, a deeper post is used for the sets. This method is proposed on its Coast division and the enlargement of the bore of Tunnel No. 6 is now in progress.

Tunnel 6, which is 3,610 ft. long, is located in the San Lucia mountains, near San Luis Obispo, at the summit of the grade, on single track. The grade from the west is ascending at the rate of 0.2 per cent to a point midway through the tunnel, where it breaks to a descending grade, eastward, of 2.2 per cent. The track through the tunnel is tangent.

The peculiar profile of this tunnel, together with adverse drafts and atmospheric pressure, causes smoke and gases to be trapped for long periods of time, making operation within the tunnel unusually difficult, in addition to causing considerable unpleasantness to passengers and crew members.

Use of Smoke Gallery

With the idea of eliminating a considerable portion of this trouble, a smoke gallery is being incorporated into the plan to extend from the east end of the tunnel to the summit, where it is to taper off for future development. This gallery, located over top of tunnel arch, when concrete lined, will have inside dimensions of about four feet wide by five feet high. Openings between adjacent timber arches of the main tunnel will permit the locomotive exhaust to enter the smoke gallery where a large portion of it will be carried to the summit and out the west end.

New timber lining is being installed with a width of 18 ft. and a height of 24 ft. 6 in. above top of rail. The old original timber lining has a clearance of 18 ft. above top of rail and a side clearance of 14 ft. at top of rail, widening to 16 ft. at the spring line.

During the process of enlarging the east end of this old bore, the smoke gallery is serving as an adit through which about two-thirds of the excavated material of the main tunnel section, and all of the excavated material of the smoke gallery, is being hauled out in mining cars. These cars are pulled by an electric tram and the material is wasted in the canyon parallel to the track.

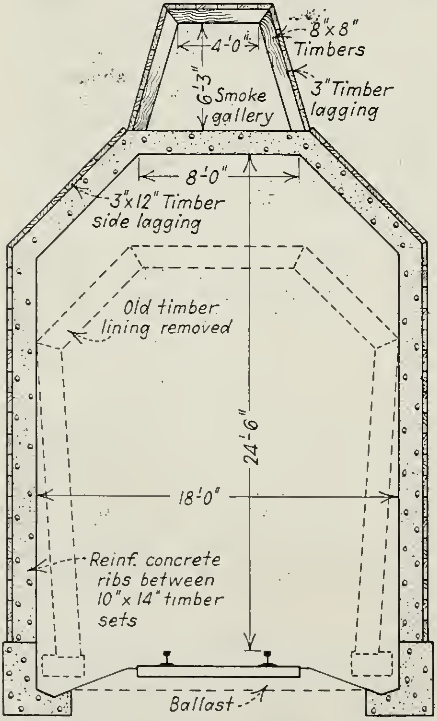
On the west end the muck is handled in metal-clad dump boxes on push cars, hauled by motor car to the west portal, where it is picked up by a stiff-leg derrick and landed on a high-line track. Here it is taken out on a trestle, by another motor car, to chutes, where it is placed in air dump cars located on a spur-track. Finally, the muck is taken by local freight service to points where it can be dumped for bank widening.

Sequence of Operations

As indicated in the foregoing, the enlargement work in this tunnel is being carried on in four separate operations.

(1) Enlargement and installation of sills, in east end, up to spring line. 16-man gang.
(2) Enlargement and installation of timber arches and smoke gallery on east end. 8-man gang.
(3) Enlargement and installation of sills in west end, by day shift. 16-man gang.
(4) Enlargement and installation of sills in west end, by night shift. 12-man gang.

Of the above men in each gang, one is stationed about one mile west of the tunnel as a flagman and one is stationed 2½ mi. east of the tunnel. These flagmen protect workmen throughout this zone, within which there are four other tunnels. The flagmen are connected by telephone with telephone operators at each end of Tunnel 6, who keep the tunnel men advised by blinking lights of the approach of trains. These operators also handle timekeeping reports.


8"x8" Timbers
4'-0"
6'-3"
Smoke gallery
3" Timber lagging
8'-0"
3"x12" Timber side lagging
Old timber lining removed
24'-6"
18'-0"
Reinf. concrete ribs between 10"x 14" timber sets
Ballast

Cross section showing design adopted for enlarging bore of Tunnel 6 on the S.P.

Tunnel 6, as well as the one next to it, is served by electric power from commercial lines in the vicinity. Two hundred-watt electric lamps are placed on the line at intervals of 100 ft. throughout the tunnels. In addition, outlets are provided at suitable places for drop cords and lamps where necessary to light up the work.

In the area at each end of the tunnel electric power is provided for lighting and for the air blower, 315 c.f.m. compressor, ½-yd. mixer, table saw, grinder, and various small drills and saws. On the west end power is available for the operation of a two-ton hoist and small tools.

The batteries on the tram car are also charged by this service. The circuit in the tunnel is so arranged that when all lights are turned off by the tunnel gangs, a train passing through the tunnel automatically lights them up. This provides light for trainmen in the event their train is stopped in the tunnel.

In addition to electric power, air power is used for operating jack-hammers, stope-hammers, pneumatic spades, gads, pumps for dewatering sill trenches, and the one-ton air hoist in the smoke gallery which pulls the mine cars up to the heading to be taken by train to the dump.

Sills

The first step of enlarging the tunnel involves the installation of a continuous reinforced concrete sill on each side of the tunnel to receive the new timber sets and, of course, the concrete lining. These sills are installed just behind the old timber sets, which have a clearance of only 14 ft. at top of rail.

Excavation for the sills is made to a depth sufficient to obtain a satisfactory foundation, which is ordinarily about 30 in. below top of rail. The tops of the sills are finished off at a point 6 in. above top of rail. Unstable or soft ground requires greater depth, wider footings and more reinforcement. The width between sills is 17 ft., or one foot less than that between faces of posts, which is 18 ft.

A reinforced V-shaped concrete gutter, to support the drain boxes, is allowed for when placing the reinforcing steel in the forms. This is done by placing stubs to protrude from the sides, to which the gutter steel will later be attached.

Weep holes are installed at 10 ft. intervals along with the concrete sills. The work in the main section of the tunnel is carried on by a foreman and 10 men.

The concrete aggregates for the sills are unloaded from cars on a spur track, at the east end of the tunnel. Here also is a cement house and a mixer. The concrete is delivered to the forms in the tunnel in one-yard steel dump boxes, arranged for unloading by means of a hydraulic lift. These boxes, hauled in on push cars by motor car, unload from the sides, which affords ease of handling and speed in getting material into the tunnel.

After completing the concrete sills, work is resumed on the sides of the tunnel, cutting it back to permit the installation of the posts and lagging. Finally the struts are placed between posts.

In preparation for future concrete lining, the timber sets are fully planked up and well packed, so that when concrete is eventually poured, there will be no giving away. All of the side cutting and installation of posts in this end of the tunnel is done on a jumbo car as there is no overhead work to be done by this gang. The gang working above the spring line enlarges the bore and sets all the arches.

Drilling and Blasting

An assistant foreman and eight men work out all the ground above the old arch sets, down to the spring line of the new arch sets. Drilling and blasting are necessary for every foot of the work. Water liner stope-hammers on 6-ft. columns are used for drilling, the water being forced to them by air pressure from a small pressure tank located on the floor of the main tunnel.

Obviously, very light shots must be placed to avoid breaking down the old, soft, original redwood sets. As a further precaution, these old sets are reinforced at the angles of the arches by spiking scab blocks on the sides. Each hole in the face must be fired independently to prevent this damage, and each blast pulls approximately six feet of depth from the face. This additional excavation of the original ground extends 6 ft. 6 in. above the old bore and 2 ft. on each side of the main tunnel.

The muck is hauled out of the tunnel in mine cars, which are pulled up a short incline into the smoke tunnel by a one-ton pneumatic hoist. From there, out to the dump, they are handled by an electric tram.

After completing a section of excavation of about 100 ft. of tunnel, the gang then sets wooden sills on each side of the tunnel at the spring line to receive the arches. These sills are framed and carefully laid, and the new arches are set up on them and completely lagged and packed. The main tunnel posts are placed under these sills by the gang below in the main tunnel, to complete the section.

After this hundred feet or so of arches is completed, the assistant foreman and his gang start excavating and timbering the smoke gallery above them. The timber lining of this gallery is composed of 8-in. by 8-in. timber posts and caps, with 3-in. plank lagging, all well packed.

The muck is taken directly through this smoke gallery in the mine cars. This gang can carry on most of its work without interference from smoke as it is supplied with fresh air blown into the heading through a rubberized, acid-resisting canvas tube, 16-in. and 20-in. in diameter, which is hung on a No. 9 wire close to the floor of the smoke gallery.

The blower, rated at 3,410 cu. ft. per min. of air at 2,000 ft. distance, is located in a shed at the portal of the smoke gallery, on top of the portal of the main tunnel. This service has been satisfactory as long as this upper section can be sealed off from the main section of the tunnel.

No concrete lining has been placed in this tunnel, except at the small section near the summit and the section at each end, already mentioned. This work was done many years ago. When enlargement of the east one-half of this tunnel is completed the work of installing concrete lining will be started.

Tunnels 7 & 8 on S. P.

Following is a description of the enlarging and lining of tunnel No. 7, 519 ft. in length, and No. 8, 678 ft. in length, on the San Joaquin division of the Southern Pacific's main line in the Tehachapi mountains.

Both of these tunnels were unlined since their original bore, and to avoid constant combing of the deteriorated rock sections, it was decided to line them with concrete.

The enlargement of the bore was done by blasting and trimming with pneumatic gads, to get the desired rough dimensions to receive a 9-in. thick concrete lining. Reinforcing bars ⅞-in. diameter were set at 12-in. centers, vertically and over the arch, and ½-in. diameter bars were placed at 12-in. centers, horizontally throughout.

Jumbo cars were employed and constructed in such a manner that all points in the perimeter of the bore could be reached by tunnel men with the air tools to do the scaling of the bore, which was completed before construction of the footings was undertaken. The excavation was then made for the footings, and ⅞-in. diameter steel dowels were set at 12-in. centers as anchors for the concrete footings. The concrete footing was poured to top of rail, and dowels were set for vertical reinforcing bars and allowed to protrude 12 in. Weep holes 8 in. by 8 in., at 10-ft. centers, were installed. Prior to setting up the wood side forms, eye bolts were grouted into the rock sides of the tunnel, at required spacing, for holding back forms. Wood side forms, 16 ft. in length, were then set up, the tops of which were 12 in. above the tunnel spring line. These forms were then filled. This length was chosen as the maximum that could be filled conveniently in one day's pour.

The top forms, 12 in. in length, were constructed of 5-in. by 5-in. angle iron ribs, with 3-in. by 6-in. sheathing bolted to angles which were 36-in. on centers.

The concrete was mixed outside the tunnel and was hauled into the tunnel on push cars to the pneumatic placing machine, from which it was forced by air through a 6-in. steel pipe into the forms. Both sides and the top were handled in this manner. The placing machine was kept inside the tunnel in bays, at 200-ft. intervals, previously cut out of the side of the tunnel for this purpose. A force of 16 men, one assistant forman and the foreman handled these jobs.

On the Salt Lake Division

On the Salt Lake division all concrete lining was done with the "Rib Design." This work was done by first cutting off the old timber posts and shoring them back. The excavation for sills was then made and concrete poured for a distance of 50 to 75 ft. The excavation was then made, timbers set back to standard clearance on top of the concrete sills, and reinforcing steel placed between the bents.

Portable forms, one for each rib, were constructed with 3-in. shiplap sheathing and lined with plywood to the spring line. These forms were held in place by ¾-in. by 9-in. lag screws and 3-in. walers every 2 ft. The arch forms were constructed in three sections; one on each side and one in the center.

The concrete was mixed outside of the tunnel and loaded into self-dumping buckets by a small crane, and then hauled into the tunnel with a track car. The concrete buckets were then hoisted up with a pneumatic hoist to the top of the side section of the arch form, and the concrete was dumped into the form. The bucket held ⅛ cu. yd. of concrete.

Work was carried on without delay to traffic, as there were 11-mi. indicators each direction from the ends of tunnel, which gave ample time to clear. The longest tunnel on this work was 3,926 ft.

On New York Central

In connection with the building, in 1927-1929, of a third and fourth track between Garrison and Beacon on the main line of the New York Central—along the Hudson river—two existing 2-track tunnels were enlarged and lined with concrete. One of these tunnels is north of Garrison, and the other is at Breakneck, south of Beacon. At Garrison, railroad traffic was handled during construction through an existing 2-track open cut. At Breakneck, traffic was handled during construction through a new 2-track tunnel built to the west of the old tunnel.

The old tunnels were through solid rock and were unlined except at the portals. They had a minimum cross-section approximately 25 ft. wide by 16½ ft. high. The tunnels were enlarged to 33 ft. wide by 22 ft. high from top of rail, with tracks on 13 ft. centers. The tunnel at Garrison is 464 ft. long and the one at Breakneck 515 ft. long. Practically all of the cutting was made on the easterly side at Garrison and on the westerly side at Breakneck. Rock was hard and fairly solid throughout, in both tunnels, and there was no drainage problem.

A heavy timber framework was erected on a flat car, to which was attached a 4½-in. diameter steel pipe curved to the shape and size of the tunnel bore. On this pipe were mounted pneumatic drills on swivels, so they could be aimed in any direction and moved laterally on the pipe support. At the portals, in starting the cut, 330 holes, 6 ft. deep, were drilled approximately horizontal. Broaching tools were then attached and the holes were opened into each other, cuttting a kerf or channel the size of the completed tunnel around a center rock core. The kerf was 6 ft. deep. Other blasting holes were drilled into this core, into which light charges of dynamite were placed and fired by from one to six delayed explosions. The kerf formed an air cushion around the seat of the explosion and, combined with the delayed blasts, caused a minimum of concussion.

Throughout the tunnel bore, back of the portals, the drilling equipment included one stoper, which was used to drill the holes in the arch about 45 deg. each side of the crown point, and three drifters which did all of the remaining drilling. In order to minimuze shock from blasting, spring holes were spaced three feet and only about ¾ lb. of explosives was used per cubic yard of rock excavated.

In the lining work, which was similar in each case, two portable form carriages were used, operating on temporary tracks, one carrying arch forms and the other forms for the side walls. In both cases the forms were of wood and were hung on the carriage frames so they could be moved inward from the neat line of the lining when it was desired to move them forward.

In order to insure true alinement and contour of the lining, without the necessity for constant engineering assistance or for keeping the form carriage tracks in true surface, the first six inches of the side walls were constructed integral with the wall footings at the time they were placed. This provided an accurate gage for securing the true alinement and proper elevation of the side wall forms as they were moved forward, and resulted in saving considerable time and expense in resetting the forms.

Twenty-four linear feet of the arch and side walls were poured on alternate days, the wall lining work always being kept in advance of the arch lining. All of the concrete was placed by pneumatic concrete gun, which operated at a pressure of 100 lb. and delivered 14 cu. ft. of concrete in a batch. The gun was discharged from a ½-cu. yd. concrete cart with a track mounting, which conveyed the concrete from a mixing plant set up near each tunnel. The lining was not started until the rock boring was completed for the full length of the tunnel. About 10 cu. yd. of concrete were required per linear foot of tunnel and the work proceeded at the rate of approximately 12 lin. ft. per day.

All of the work was done under contract at a unit price per linear foot, with extra payment for broaching. As the tunnels were short, there was no artificial lighting or ventilation problem to be taken into consideration.

On Pittsburgh & West Virginia

On the Pittsburgh & West Virginia, two tunnels were lined with concrete which were previously timber lined. Concrete was placed using collapsible steel forms and was pumped into place, the work being done under contract.

Within recent years repairs have been made to extensive sections of double-track concrete-lined tunnels where section of the arch concrete had failed or was damaged by coal-mining operations. These repairs were made by cutting a bench near the spring line and seating thereon coated steel liner plates. Grout was forced back of the liner plates and steel plates and shot crete applied.

Greenwood Tunnel, C. & O.

To avoid restricted clearances in the Greenwood tunnel of the C. & O., studies were made leading to one of the following methods of carrying out the work:

(1) Enlarging the present tunnel to modern clearance requirement.
(2) Rerouting the railroad to eliminate this clearance bottleneck.
(3) Daylighting the present track by supporting the present 4-ring brick bore to keep traffic moving while blasting and excavating operations were proceeding.

After due consideration, proposal No. 3 was decided upon as the most economical. To avoid delays to traffic while daylighting operations were in progress, a steel liner plate was used and formed to fit inside of the existing brick lining. The steel liner rings were of the box, corrugated type, 18 in. wide, made up of 10 plates so fabricated that all work of placing them was done inside. The steel liner plates were supported on timber sills which were braced to the ends of the track ties.

Big Bend Tunnel, C. & O.

The Big Bend tunnel of the Chesapeake & Ohio had sufficient width, but required an increase in height of 12 in. to meet present operating requirements. A new tunnel, 100 ft. to south, was used to carry all traffic during enlargement of the old tunnel, which eliminated many of the construction difficulties. The old tunnel had a brick lining, in generally good condition, so it was determined to increase the vertical clearance by lowering the floor.

After the track was removed, a force of men with jack-hammer air drills started at west end drilling holes in the floor—which was of limestone formation—on about 12-in. centers. Another force of men using pneumatic paving breakers broke up and undercut the rock to the proposed bottom elevation of the new concrete floor. No blasting was permitted because of the hazard to the old brick lining. Excavation near the sidewalls was stepped inward approximately 18 in. to avoid undermining the brick lining. These steps served as supports for construction blocking during subsequent pouring of the new concrete floor slab.

The new concrete floor was sloped both ways toward the center, where it has a depth of 18 in. The track is supported on wood blocks 10 in. by 8 in., by 2 ft. 6 in. long spaced on 20 in. centers. These were embedded in the concrete so their top surfaces at the outside were flush with the concrete. Ties were set in cement grout mixed with an admixture to insure against shrinkage during setting and curing and to give a high early strength. This in turn insured accurate line and surface.

DISCUSSION

In the absence of Chairman Eichenlaub, this report was read by Vice-Chairman Harman. K. L. Miner (N.Y.C.) inquired whether liner plate lagging should be left in place after completion of the concrete work on a relining job. Mr. Harman replied that this would depend upon the character of the corrosive agents back of the new lining, stack abrasion on the exposed surfaces of the liner plates if they are not protected, the precautions taken in the selection of materials, and the care given to the placing of the shortcrete covering of the liner plates.

Housing Bridge and Building Employees

Report of Committee

W. W. Caines (chairman), asst. supvr. b. & b., C. & O., Huntington, W. Va.; J. J. Healey (vice-chairman), asst. supvr. b. & b., B. & M., Boston, Mass.; H. A. Hunt (vice-chairman), div. engr., T. & N. O., El Paso, Tex.; H. F. Bird, supvr. b. & b., N. Y. C., Syracuse, N. Y.; I. C. Brewer, div. engr., C. M. St. P. & P., Milwaukee, Wis.; W. J. Cable, div. engr., Soo Line, Stevens Point, Wis.; P. B. Collier, supvr. b. & b., M. P., St. Louis, Mo.; A. M. Glander, ch. carp., C. M. St. P. & P., Mason City, Iowa; W. R. Graham, asst. supvr. b. & b., C. & O., Covington, Ky.; H. M. Harlow, asst. gen. supvr. b. & b., C. & O., Richmond, Va.; F. F. Hornig, div. engr., C. M. St. P. & P., Mason City, Iowa; P. L. Koehler, asst. supt., C. & O., Peach Creek, W. Va.; W. F. Martens, gen. fore., b. & b., A. T. & S. F., San Bernardino, Cal.; R. L. Norton, mast. carp., S. A. L., Savannah, Ga.; L. E. Peyser, arch. S. P., San Francisco, Cal.; C. J. Shapland, asst. engr., C. V., St. Albans, Vt.; W. B. Starnes, br. insp., St. L. B. & M., Kingsville, Tex.; W. L. Turner, Jr., eastern editor, *Railway Engineering and Maintenance*, New York; and J. F. Warrenfels, Jr., mast. carp., S. A. L., Savannah, Ga.

It is evident that as railway bridge and building programs expand to meet changing and growing needs on the railroads, we must modernize the methods of housing bridge and building employees. The day of the obsolete and poorly furnished and maintained bunk cars is nearly over. The demands of progress make this necessary for many reasons.

Camp Cars

Camp cars for B. & B. and other road forces vary greatly in design. The availability of cars not required for revenue service determines to a large extent the type of cars used. Obsolete coaches, box cars, troop sleepers and all kinds of cars which can be converted to camp cars have been and are being used, Some roads have comprehensive programs for camp-car renewals and, of course, the best that the appropriations allow are being converted. Standardization of design to meet present-day requirements is recommended by the committee.

The usual cars in a boarding or camp-car outfit include sleeping, kitchen, diner, recreation, tool and material cars. In sleeping cars, it is considered good practice to separate individual bunks with lockers to provide adequate fresh air for sleeping men. Arrangements vary, but are made with the view of meeting practical requirements for comfort. When the size of the force permits, lobby space with chairs, tables, etc., can be provided in a portion of the sleeping cars. Where larger forces are involved, it is considered good practice to have separate recreation or lobby cars, furnished in accordance with the requirements of the force.

The lobby and wash car, if separate, should be placed next to the dining car and equipped with individual lockers. The washing and bathing faciliites in this car should meet the requirements of those sanitation rules applicable.

The kitchen and dining car for forces of ordinary size should have a small bunk room off the kitchen for a cook's quarters, equipped with his bunk and a cook's small writing desk and chair.

This is desirable to prevent disturbing the cook or other men, whose sleeping hours are at different times.

Sanitation

Sanitation measures must meet all state and federal laws that apply. In sleeping cars, the number of bunks should be based on allowing 40 to 50 sq. ft. per man, figured on total floor space. Floors and walls should be of such design as to permit easy cleaning, and light colors for walls and ceilings are recommended for light and decorative purposes.

Coal or oil-fired hot water heaters are recommended for uniform heating. Windows should be located to provide adequate ventilation and all doors and windows should be screened. It is desirable to wire living and dining cars for electric lights, the power to be furnished from either stationary or portable sources. Bathing and washing facilities should be provided with adequate water storage tanks, to be filled by a hand or engine-operated pump. Lockers of satisfactory size should be provided.

Drinking Water

Drinking water coolers meeting Public Health Service requirements are recommended. Portable privies or chemical toilets, properly constructed and maintained, will comply with Public Health Service regulations.

Kitchen and dining car design should, in general, conform to the design of bunk cars with respect to floors, walls, ceiling, screening and lighting. Ventilation over stoves should consist of metal hoods and exhaust fans. Tables and shelves should have smooth, water-resistant surfaces, easily cleaned. Storage facilities for packaged and non-perishable foods should provide protection from insects, dust and other contaminating influences. Refrigerators of adequate size and design to store perishable foods should be provided. Sinks for dishwashing, constructed of non-rusting materials, and water heating equipment are necessary.

Sanitation Rules

Sanitation rules for camp cars must provide for responsibility as to enforcement, and should be uniform for all types of forces. The organization should provide adequate personnel to operate and maintain properly the sanitary equipment furnished. Requirements for cleaning, heating, cooking, waste disposal, insect control, drinking water, toilets, etc., should be definite and clear, and supervising officers should see that they are followed.

The foregoing recommendations governing sanitation conform in general to tentative recommendations of the American Railway Engineering Association.

Handling of Meals

The cooks usually work the same hours as the men in the force, plus additional time necessary before meals to prepare the food, and after meals to clean up the kitchen and dishes, to be ready for the next meal. On some roads cooks are paid one or two hours additional time at pro-rata or time and one-half for the extra time worked.

In large forces very few cooks pay board. In small forces they usually pay the same board as those in the force are required to pay. In some gangs, the cooks pay for one meal a day. This matter is usually optional with the force personnel and no set rules govern.

Board arrangements are made according to the method adopted by the force for paying for their meals. On most roads the meals are pro-rated to each man on the basis of total meals in the cars between pay days. Other roads have a so-called "jack-pot," where each man puts a certain amount of his pay in the jack-pot each pay day. Shopping for groceries is then carried out according to the amount of money available.

Some roads have considerable difficulty in obtaining and keeping good cooks for their road forces. The lack of a good cook can do much to lower the morale and efficiency of a force. Some better system for training and holding cooks is very desirable, and improved collaboration between B. & B. and personnel departments might improve this weak point, which is so vital to the maintenance of good road organizations.

Protection of Camp Cars

There are several different ways of protecting camp cars, set off along line, against train accidents. One method is to provide so-called bunk-car discs which are attached to the leading switch on the siding where cars are stored. In addition to the discs on the switch, the first car should be protected with amber lights, placed on the end of the car in the same position as on a caboose or end of train.

When occupied cars are set on a siding, the switches at each end should be spiked to prevent any possibiilty of a train striking the cars. Another method consists of using special derails, equipped with disc and light, and locked to the outside rail. This type derail cannot be removed except by permission of the foreman in charge of the cars. When the size of the job to be done warrants, and it is feasible to do so, camp cars should be set on temporary dead track disconnected from the operating track.

Fire Protection

Every bunk, lobby and dining car should be equipped with standard fire extinguishers placed inside the entrance door. Kitchen and tool cars should also be equipped with carbon tetrachloride, soda and acid or other approved types of fire extinguishers. Rules for fire prevention should be posted in all camp cars and supervision exercised to enforce them.

When camp cars are wired for electricity, and it is practical, gangs are provided with electric lights. Some camp car outfits are equipped with portable generators for lighting. When electricity is not available, oil lamps of approved design are used.

On some roads the maintenance of the inside of cars is taken care of by the bridge and building forces; and body and running-gear repairs are made by the local car department. On other roads, when the cars get to a point of heavy repairs, they are sent to the car shops for general repairs to the body and running gear. The maintenance of good paint standards in camp cars is very essential for good housekeeping and good morale among the forces.

Bunk Houses—Permanent

Bunk houses for bridge and building employees should be 24 feet wide and 60 to 80 feet long, with a hall running through the center for about 40 feet and rooms to each side for two men. A recreation room should come next, with toilet, showers and wash room leading off from the recreation room. The dining room and kitchen should be on the end, and a porch should run the full length of the building on one side. This arrangement will take care of 12 to 16 men. The ideal arrangement is then completed by having a centrally located heating plant, large enough to take care of the necessary hot water for kitchen and showers, unless a separate unit is desired in the shower room for hot water.

Permanent camps are generally more satisfactory throughout the course of the year. The men usually are better satisfied as to the amount of room available in these camps. The camp is generally located more advantageously for obtaining food supplies, electric current and off-hour recreation for the men. Transportation of the men to and from jobs is usually provided by trucks or motor cars. This item is of great importance in selecting the locations of permanent camps.

The type of camp to be used will probably vary according to the climate in which it is situated. The permanent type is more desirable where temperatures are extreme, as better protection can be provided in this type against wide ranges of temperature by means of insulation, better heating facilities, et cetera.

Bunk Houses—Portable

Bunk houses of movable size, or of prefabricated design which can be erected and "knocked-down" easily, are advantageous for portable camps. Trailers have been used on some roads. A fair size portable camp outfit can house 40 to 50 men.

The kitchen and the dining room should be separate from the bunk houses. The refrigerator and commissary department should be located directly off the kitchen, and the sleeping quarters for the cook and helper should be near the kitchen and commissary.

Where a large number of men are housed, it is usually very desirable to have a recreation room separate from the rest of the building. The heating plant should be centrally located and large enough to take care of the necessary hot water for kitchen and showers, unless a separate unit is desirable in the shower room.

The desirable arrangement for toilets is in a central location in a separate wing of the buildings between the sleeping quarters and the showers. If this arrangement is used the hot water tank for shower baths can be in the same wing of the building, with the storage tank and heater combined. All rules governing sanitation for camp cars should apply for portable bunk houses.

The advantage of a portable camp is that it can be moved when necessary. It can be located near the work, and thus effect a large saving in man-hours traveling to and from the camp.

A portable camp can also be located where water and other facilities can be obtained at minimum cost. This will result in large savings if the railroad is able to use its own source of water supply, power, etc.

Transportation of Gangs

On most roads B. & B. men are usually transported by motor car to the site of work. If a long-distance travel is required, either for emergency or short jobs, transportation is usually by truck or work train. In some cases, regular passenger trains are used when the leaving and arriving times of such trains do not entail too much travel time and overtime.

Many man-hours are lost waiting for clear track when transportation is by motor car, especially in long blocks where signals must be clear before the gang is allowed to operate the car. This lost time could be avoided where railroads parallel improved county, state or federal highways, by the use of trucks. Materials can also be transported more economically in trucks and with less chance of interfering with train operation.

Conclusion

In housing bridge and building department employees, the important thing to consider is to provide as many of the comforts of home as it is possible to provide and properly maintain. This is desirable from a morale standpoint in order to keep the off-hour needs of the men as well satisfied as possible while they are away from their homes. Railroad men today, especially in the mechanics' class in B. & B. work, will not be content in their jobs unless this is done, and a heavy turn-over in skilled labor will follow, with resultant loss of efficiency in the gangs.

All this means that comfortable quarters with good heating and lighting facilities, shower baths, plenty of room for recreation and reading, and, most of all, good meals, are necessary to obtain the best results from B. & B. road forces. A good safe workman must be a satisfied workman. Most railroads recognize this, and have generally improved, or are now improving, the housing facilities of their road forces, including B. & B forces. Dividends from the investment in such improvements will be paid in greater efficiency and productivity of their forces.

DISCUSSION

President Hancock referred to that part of the report dealing with camp cars and stated that his road recently built some shower cars for bridge and building gangs because they included many veterans whose military training taught them to enjoy showers and accept them as part of good personal hygiene.

F. M. Misch (S.P.) stated that each of his crews has a bunk car equipped with two showers, it being found that one shower was insufficient for a crew. A recent improvement on his road, he stated, was the assignment of at least one remodeled Pullman tourist car to each road gang but, because these cars might again be used in revenue service, the remodeling work was limited and the men did not have all of the room they felt to be necessary.

E. H. Barnhart (B.&O.) recommended that side tracks be disconnected from the main track when camp cars are spotted on them. This is safer than the use of derails, he said. When Mr. Barnhart inquired if any road was using troop sleepers, W. K. Manning (Erie) reported that his road had assigned some to its signal department forces but, as yet, none was being used by bridge and building crews. He also observed that one fault of many camp cars is in having an inadequate electric power supply to run power pumps and refrigerators, and that it would be better to design camp cars to have a separate room for each man.

W. C. Harman (S.P.) stated that his road had remodeled some cars having steel underframes to provide six bedrooms, each about 6 ft. by 7 ft., so that every man could have a private room, with a lockable door, where he could have his radio and other personal possessions. Each of such cars on the road's southern lines has a stove for heating purposes but, on the northern lines, each car has steam pipe coils extending from a small central heating plant for the full length of the car.

Lee Mayfield (M.P.) said that he was recently assigned some 70-ft. coaches for redesigning into camp cars. His plans contemplate a room, approximately 10 ft. square, at one end of each car for an assistant foreman, and the use of the adjoining 11 ft. of car length for a shower room. At the opposite end of the car, 12 ft. of the car length will be fitted as a recreation room, while the intervening space will have a center aisle, with bunks and lockers on each side for accommodating 10 men.

Answering a question by J. A. Hanson (N.Y.C.) regarding the ventilation of camp cars, Mr. Mayfield said that some cars are provided with large fans at one end of the center aisle while others have window fans.

Protection to Bridges Over Navigable Streams

Report of Committee

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IN THE early years of this country's history, transportation of commodities was largely water-borne. This started with the movement of heavy bulk materials to tidewater by river routes, and expanded to include all early-day articles of commerce that required transport. Later as rail transportation developed and was extended across water-borne transportation routes, the railroads were required to build and protect their crossings in a manner most convenient for the water routes. In many instances, the expansion of the rail lines was dependent on the exchange of traffic between the two forms of transportation. Under these circumstances the railroads benefited and therefore were instrumental in providing exchange facilities and necessary aids to water-borne traffic. Later, however, it became a contest between the two forms of transportation, one quite well established, the other just beginning.

However, from those early days until now, the bridge owner has been obligated to furnish and maintain protection for his bridge, also to provide any necessary aids to navigation. Control of these matters has always been effected by the Federal Congress, through the chief of engineers of the War Department. Instances are recorded wherein this officer in the early days personally visited the location of rail crossings over navigable waters and prescribed the form and extent of the protection and of the aids to navigation. Later official regulations controlling all phases of water-borne transportation were issued as a basis for uniform procedures, including the positioning of navigation lights on different types of protection. Conformance to these regulations has, for many years, formed a part of all construction plans, and such plans, to be legal, must carry the approval of federal and state authorities. The current regulations relative to navigation lights, issued in 1947, are under jurisdiction of the U.S. Coast Guard personnel.

The pattern for water-borne traffic has changed tremendously during the past century, and in many instances, since the date of construction of many of the existing railroad movable bridges. Because of these changing conditions many of the older bridges are no longer operated, while many others are required to accommodate water-borne traffic of a totally different character than was originally contemplated.

The change in type and character of the vessels themselves has had a tremendous effect on the situation. Formerly they were of relative small capacity and propulsion power, generally of wood construction, and consisted principally of steamboats of the stern-wheel type, equipped as pleasure boats or as barges to handle work equipment, such as derricks and dredges, or tows of wood barges loaded with fuel, construction materials, staple commodities of various kinds, food supplies, etc. Tows were held to a minimum number of barges for safe operation and navigation was conducted with great care because a collision of this type of equipment with piers, fenders, or any obstruction was likely to result in damage to the equipment, and possible sinking and loss of vessel and cargo. The protection installed for movable bridges consisted of pile and timber construction suited to this early day inland water-borne traffic.

Present day water transports ply in coastal and intercoastal ocean waters and the waters of our inland lakes and rivers. They comprise many types of inland and ocean-going vessels including pleasure and commercial passenger vessels, trawlers and small fishing boats, cargo barges and vessels, combination passenger and cargo vessels, tankers, hopper-type barges, derricks and pile-driver barges, dump scows, dredges, tow boats, tugboats, Great Lakes freighters and car ferries, automobile-carrying river craft, naval vessels of many types, to mention a few. They transport mineral products, petroleum products, products of chemical combinations, manufactured articles, construction materials and equipment, in fact practically every article known to commerce.

In size, they range from small pleasure boats to lake freighters over 600 ft. long with beams of 67 ft. and a capacity of 18,000 tons, hopper-type coal barges having a capacity of 41 railroad cars, lake vessels accommodating 3,500 passengers and 110 automobiles, and barge tows of one to four units, each containing 7 to 8 thousand barrels of oil and other liquids—just to mention a few of the larger classes of transport. Of great significance, is the fact that most of the transports now in service are of steel construction and therefore damage to them, resulting from contact with railroad structures, is rare. Reasonably, it may be a feeling of security on the part of the operators, as to freedom from damage to water-borne transport, that results in much less precaution being taken, by operating crews, than was the case when damage to the vessels was the rule rather than the exception. Barge tows, consisting of one to twelve units, generally, are the worst offenders. When this class of transport is handled by a single tug boat, at either the front or rear end the opposite end is very difficult to control as it is easily affected by cross winds and channel currents.

Stream Characteristics

Stream characteristics at the location of many of the movable bridges are important factors in determining the extent and the kind of protection needed. They influence the safe handling of water-borne transports to a marked degree, and, in many instances, to such an extent that navigational control of a vessel is temporarily lost. The adverse stream characteristics generally encountered include: (1) velocity and direction of channel currents, (2) velocity and direction of air currents, (3) fluctuating water levels due to tides and floods, and (4) temporary fluctuations in the stream-bed level of navigable channels. Without doubt, the first two adverse conditions account for the major portion of the damage to protective installations and to the bridge structure when these installations fail due to their inadequacy or otherwise.

Tidal changes and floods, possibly to a lesser degree than the conditions just mentioned, are the source of much navigational difficulty. Tides cause reversal in the direction of stream currents, accompanied by changing cross currents. Rarely does a boat move through a movable span twice under exactly the same conditions. Generally the action of cross currents is unpredictable, particularly as to their effect on barge tows. The free end of a barge tow, whether loaded or empty, is greatly affected by cross currents, wind and wave action. There is little the tug boat can do except to maneuver one end of the tow in the best manner possible under the prevailing circumstances, in attempting to navigate through the open draw.

Due appreciation must be accorded the fact that no single type of protective installation will suffice for all conditions. This is so because the types of transport vary so tremendously as to class and capacity, the commodities transported are so diversified and sectionalized and in general the navigational equipment and practices are so dissimilar for different classes of transport. We as railroad men, appear to be prejudiced against water-borne transportation. There is good reason why, and we are possibly disinclined to familiarize ourselves with the problems confronting operators of water-borne traffic. At locations where specific classes of traffic experience unusual navigational difficulty, construction work designed to assist in their control would be of benefit to all parties.

The protection needed to withstand the hazards of present-day water-borne traffic must conform to the conditions at each crossing, as determined by the type of movable span, the physical characteristics at the site and the character of the predominating water-borne traffic. Each location constitutes an individual problem because of the many variable factors involved. The width of the navigable channel is fixed by the type of movable span, and it remains so during the life of the bridge. Channel and weather conditions at many sites are subject to frequent and unusual changes, and in addition water-borne traffic follows unpredictable cycles of change, all of which affects the problems connected with movable bridge protection.

The types of movable spans include the swing span, the pontoon span, the bascule span, and the lift span. Protection for a swing span usually is built of wood piling and framed timber. It is designed of sufficient width to protect the sides of the span and long enough to support the ends of the span in the open position. Generally these structures are pointed at the outer ends, and beyond these pointed ends, pile dolphins, rock filled cribs, or masonry ice breakers are installed to give additional protection for the ends of the draw span. Protection for the rest piers of swing spans, and for bascule and lift spans, usually is not so extensive as that for the center pier of a swing span, and consists of fenders constructed of wood piles and framed timbers, terminated by wood pile dolphins. Sometimes wood pile dolphins are used instead of fenders.

Several types of fender construction are used in the immediate vicinity of piers and abutments. These include the following: Waling timbers directly anchored to the channel faces of these units; waling timbers and sheeting bolted to a single row or a double row of wood piling; and steel I-beams framed to form a bumper beam that spans the full length of the pier footing. Sometimes the pile and timber fender is reinforced with small pile dolphins, driven at each end of the pier footing. Bumper beam fenders are straight, angular or circular in outline. They do not make contact with the bridge pier, but are framed to dolphins at each end. One type of dolphin consists of a cell formed by steel sheet piling, driven in a circular or other pattern to suit the location, and filled with concrete or other heavy filling. The use of concrete filling permits the encasement of the ends of vertical beams to which the bumper beam is anchored. Sometimes the bumper beam is framed to the side of the cell before the filling is placed.

In other instances, the ends of the bumper beam are framed to wood pile dolphins. These dolphins consist of five or more vertical piles and at least two batter piles, and a row of vertical piles and posts (posts rest on pier footing) provide vertical support for the bumper beam, each beam being anchored to each pile or post with a large U-bolt. Wood sheeting is spiked to the channel side of the vertical members. A large timber wale at the top of the fender extends the full length of the bumper beam and beyond to other pile dolphins which form one corner of fixed sheer booms that extend outward from the ends of the bumper beam.

An example of another type is a welded steel fender built at a swing span on the Black river at Lorain, Ohio, which consists of 14-in. steel bearing piles braced with batter piles of the same section, all driven into soft rock. This fender has a truss section along the channel side of the center pier of the swing span. It was necessary to encroach on the navigable channel to accommodate this shallow horizontal truss. The Lake Carrier's Association made no objection to this construction and the U. S. District Engineer furnished the necessary permit. River traffic past this bridge is mostly deeply-laden lake vessels loaded with iron ore and being moved up stream by one or two tugs.

Pile and timber fenders or fixed sheer booms are generally installed at one or both ends of the protection adjacent to bridge piers. Fenders consist of single, double, or triple rows of wood piles, with wale timbers and sheeting on the channel side. Spacer timbers are used between multiple rows of piles. Batter piles are used extensively, particularly where the top of the fender is 12 to 15 ft. above low water. A double row of batter piles, one at low water and the other at high water, is used in locations where water levels fluctuate widely. Fixed sheer booms consist of two rows of wood piles spaced 6 to 8 ft. between rows, and 4 ft., 6 ft. or 8 ft. apart in the rows. They are capped and braced and waling timbers are bolted to the piles on the channel face of the boom. In some instances the waling timbers are omitted and a float is provided which acts as a bumping surface that follows fluctuations in water levels. This float is a fully-enclosed timber box about 4 ft. square. It is placed on the front face of the fixed boom and is connected to a wale timber on the rear face of the boom by cross-timbers, thus forming a vertically moving unit.

Dolphins constitute an important feature of nearly all protection installations. Wood pile dolphins predominate and are designated by the number of piles in each, such as a 7-19-37-61 or 120-pile dolphins. The piles are spaced in circular rows of larger diameter at the channel bed than at the top so that, when pulled together at the top for wrapping, the batter of the piles adds stiffness to the dolphin. One or more series of cable wrappings are placed near the top after the piles are drawn together tightly. Sometimes circular steel plates or a facing of hardwood piles is provided above low water for a rubbing surface. Frequently after a dolphin has been completed, steel batter piles, generally three in number, are driven and framed to a semi-circular steel plate which is then fastened securely to the dolphin. Another way of increasing the shock resistance of a wood-pile dolphin consists of driving steel I-beam between the piles in the outside row facing river traffic. Still another type of dolphin is the steel sheet piling cell filled with concrete or other heavy material as previously mentioned. A much larger steel sheet piling cell, filled with sand, is used at the nose of the center pier protection for swing spans.

Aids to Navigation

Aids to navigation comprise sight and steering aids. Sight aids, in addition to navigation lights placed for night use, consist of the painting of alternate black and white oblique strips on all channel side surfaces of protection installations that are not parallel to normal river traffic and the erection of sight poles, painted white, at the extreme outer end of the protection. This procedure has proved particularly helpful to navigators of low-height water craft. Steering aids comprise sheer fences at locations adjacent to a crossing, where the navigable channel makes an abrupt change in direction, and pile dolphins at the entrance to the throat of the customary protection installation. Sheer fences need no further mention, having been discussed previously.

A decision as to the size and location of these pile dolphins should be based upon the results of a thorough study of the physical conditions and the navigating problems at each crossing where need for them appears likely. Personnel representing the railroad, the U. S. District Engineers office and navigation interests should participate in this study and agree on the findings. In one such instance, the legal clearance at the site of a swing span is 60 ft. and the actual clearance between the faces of the protection is 64 ft. The car ferries operating at this crossing have a 54-ft. beam. It was proposed to install 2 wood pile dolphins, each one consisting of 61 piles cut off at 14 ft. above low water and 25 backing piles cut off at 2 ft. above low water. The clearance between the dolphins is to be 85 ft. and they are to be located a short distance beyond the end of the center pier protection and on the lake side of the crossing.

These pile dolphins will afford an operator of a vessel a means of lining up the boat at the approach to the bridge by holding the front end to a fixed position while shifting the rear end, with the propellers, to get the boat in a position to proceed through the open draw. In the case of a tow the pile dolphins should be located in such a manner as to line up the rear end of the tow, as the front end precedes through the open draw.

Attention is called to one instance wherein a movable swing span was declared inadequate by the secretary of war and the bridge is being reconstructed in accordance with provisions of the Truman-Hobbs act. This act provides a more equitable division of costs for changes ordered for the benefit of navigation interests.

Economic Considerations

It seems appropriate to record a few instances illustrating economic factors involved in collisions of water-borne traffic with movable bridges.

At one location in the Southwest coastal waters, a total of 33 collisions occurred in a period of five years involving expenditures amounting to approximately $110,000 to effect repairs to the bridge and its protection.

At a location on the upper Mississippi river the upstream protection was struck 9 times over a three-year period with repairs costing as much as $1,300 for each accident.

At the same location on this river a five-barge tow moving upstream struck the through truss swing span as it was being opened. The entire span was moved 32 in. upstream, breaking the center casting, buckling all roller shafts and pushing the span off the rollers. The cost of repairs amounted to $35,264, of which $21,156 represented the cost of detouring.

In 1940 a large double-track swing span over the Milwaukee river at Milwaukee, Wis., was struck by a car ferry and moved sidewise a distance of 12 in. The cost of resetting amounted to $5,000.

In 1940 a through-truss swing span over the Fox river at Green Bay, Wis., was struck head on while in the open position. The entire span, including the masonry center pier, was moved about 12 ft. down-stream by sliding on the timber grillage of the pile foundation. Cost of repairs amounted to approximately $104,000, of which $30,000 represented the cost of detouring trains.

In still another instance a fully-loaded freighter struck the abutment of a bascule span in the Detroit area. This abutment formed a counter-weight pit about 30 ft. below the base of rail. The pit filled with water putting the bridge entirely out of commission due to counterweight being submerged.

The first instance cited is typical for a large number of railroad bridges over navigable streams, wherein collisions by water-borne transports result in damage to protection installations and minor damage to movable spans. The others refer to collisions wherein great damage was done. All illustrate the problems faced by railway engineering officers and bridge and building personnel. These men have no control over the causes leading to collisions; however, through carefully planned protection works they can do much to minimize the damage resulting therefrom.

DISCUSSION

B. M. Stephens (T. & N. O.) reported that, in his territory, the district engineer's office of the U. S. Army has imposed penalties on the operators of boats for mishandling their vessels, and suggested that other roads might appeal to local authorities for similar action. L. D. Garis, (C. & N. W.) asked for information on protecting cut-off piles from developing center rot. T. M. Von Sprecken (Sou.), Lee Mayfield (M. P.), and F. M. Misch, (S. P.), all responded to this inquiry, telling of substantially similar methods used on their roads. These consist in substance of the application of hot creosote to the top of the pile, the creosote being retained on the pile by means of a dam of clay or other material while soaking in. In addition, Mr. Misch told of the practice of capping the pile top with a galvanized metal cap after it had been covered with hot asphalt or tar.

H. S. Loeffler (G. N.) told of the way the G. N. protects pile dolphins and waling timbers on ore docks to minimize damage by boats rubbing these facilities. In this construction a number of used automobile tires are threaded on a 12-ft. length of 14-in. timber. The timber is then mounted upright and secured to the facility by means of cables.

Mr. Garis then asked for information regarding the economical size of timber for use as fender facing in view of today's material prices. G. H. Perry (P. R. R.) said that if the vessels using the facility are of large size, the fenders will wear rapidly, regardless of size. He then told of a method of extending piles by caping them with lengths of pipes which are then filled with concrete and wrapped with steel cable. This method, he said, is highly satisfactory.

Sanitary Facilities and Appurtenances for Railway Buildings

Report of Committee

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SANITARY facilities contribute to the welfare of all people. Therefore, the various law-making bodies are interested and promulgate laws, rules and regulations to govern the constructon of such facilities.

When preparing plans for new sanitary facilities, or making adjustments to existing conditions, one must familiarize himself not only with local requirements, but also with the laws of the particular state in which such construction is contemplated. Many states have separate regulating bodies, or commissions, which pass on all plans for these facilities.

Passenger Stations

Good toilet facilities in passenger stations create much favorable comment from the traveling public, and the railroads should endeavor to construct such facilities in the best manner.

It is preferable to construct toilet rooms in passenger stations at one end of the general waiting room, and adjacent to each other so that the dividing wall can be used for piping, thus simplifying the plumbing. Sanitary fixtures should not be placed along an outside wall if it is at all possible to arrange them otherwise; this is to minimize the danger from freezing.

All walls and ceilings of toilet rooms must be plastered. The floors may be ceramic tile, or other impervious materials, and should be provided with a six-inch high baseboard, with cove at floor line of similar materials. In the more important stations, the walls to a height of seven feet may be covered with marble, structural glass, or glazed tile in order to eliminate promiscuous writing, sketching, cutting or other markings.

It is a generally accepted requirement that all toilet rooms have outside windows. The area of such window openings should be at least 10 per cent of the floor area, and with the further provision that 50 per cent of the window can be made free opening. The lower half of all such windows must be fitted with obscure glass.

Each toilet room should be provided with a ventilating duct, which is usually constructed of galvanized iron and capped above the roof line with a syphon-jet ventilator. The lower end of each duct must have an opening just above the baseboard, covered with an iron or other metal grille. Separate ducts must be provided for the toilet rooms for each sex.

All toilet rooms should have at least one lavatory, together with the other sanitary facilities. In the larger stations, where hot water is available, washing facilities should include mirrors and electric outlets at the lavatories, and a vanity in the women's rest room.

All rooms must be ventilated. Ventilation for toilet and wash rooms is obvious. It is necessary for locker rooms to provide both general air circulation and circulation in lockers where clothing may be damp. Ventilation may be provided by metal ducts from the floor line to above the roof, connected to a syphon-jet ventilator of proper size. Grilled openings at the lower ends of the duct are placed just above the baseboard. This ventilation is in addition to that provided for by window openings.

The window area must be at least equal to 10 per cent of the floor area of each room. The windows may be of wood or metal, and of such design that at least 50 per cent of the window area will open. The glass in the windows in the toilet and wash rooms should be of an opaque type, and, in some cases, the lower half of locker rooms windows should be glazed with such glass.

The sanitary facilities in passenger stations should include drinking fountains with vitrified china bowls or receptors, placed in close proximity to the toilet rooms, in order to simplify the plumbing work. Drinking fountains must be of the angle-stream type to comply with the codes of most states, and should be placed in the waiting rooms—never in the toilet rooms.

It is obvious that, where required by law, separate rooms and facilities must be provided for white and colored people.

Welfare Buildings

When necessary to provide new welfare facilities for employees, it is preferable to construct such facilities in a separate building. One building may house several classes of employees, such as trainmen, enginemen, switchmen, and shopmen. However, it is customary to provide separate wash and locker rooms for each class.

New welfare buildings are usually one-story structures with a basement to accommodate the heating plant, coal storage, and other kindred facilities. A two-story structure would, no doubt, cost less, but may bring objections from those employees who are required, by reason of occupation, to carry tool boxes or other heavy equipment, to the second floor.

On account of environment and usage, welfare buildings should be substantially constructed on concrete foundations, with concrete floors, masonry walls, and proper roof structure.

The walls and ceilings of wash and toilet rooms must be plastered, or provided with other smooth hard surface for sanitary reasons and to comply with the various sanitary codes. It is good practice to apply a hard cement plaster to the lower seven feet of walls in these rooms, but the rest of the walls and the ceilings can be surfaced with ordinary plaster. All walls and ceilings should be painted with an oil-base paint. Before applying plaster to the exterior walls of such rooms, they must be furred or provided with a waterproof bond coat to protect the plaster from the seepage of moisture through the walls.

Locker Rooms

The walls of locker rooms, if of masonry construction, need not be plastered or painted. Concrete blocks or brick must be laid with neat joints in order to present a satisfactory appearance. Two or three applications of waterproofing compound are necessary on exterior masonry walls to prevent driving rains from seeping through. Stucco, on masonry block walls, is good construction and will eliminate seepage of water through the walls.

The ceilings in locker rooms may be fiber board, plaster board or asbestos-cement board, fastened directly to the ceiling joists. It is becoming general practice to insulate all such ceilings in order to conserve heat. It is essential to ventilate the attic space over insulated ceilings in order to prevent moisture damaging the insulation.

The floors in welfare buildings should be of concrete, and, for sanitary reasons, a six-inch high base of the same material should be provided in all rooms. It is well to provide floor drains so that rooms may be flushed with water when necessary.

Doors

Doors should be of ordinary wood construction, and may be pine or fir, suitable for painting. It is preferable not to provide glass in the upper panel of these doors. The exterior doors should be 1¾ in. thick, and interior doors 1⅜ in. thick. A latching device is all that is necessary in the way of locks, as such buildings are seldom locked. Liquid door closers should be provided, especially on doors leading to toilet and wash rooms.

In certain localities it is important to provide fly screens for all windows and doors.

Sanitary Fixtures

All sanitary fixtures should be the best obtainable. In fact, many sanitary codes describe the minimum that will be acceptable. From these codes one also determines the number of each kind of fixtures required for the particular job in question.

To ascertain the number of fixtures required for any particular job, it is necessary to determine the maximum number of men on any eight-hour shift. Various states employ different methods of figuring the minimum number of fixtures required, and their codes should be consulted. However, the minimum requirements are about as follows:

1 wash bowl, or wash facility for each 10 men or fraction thereof;
1 water closet for each 20 men or fraction thereof;
1 urinal for each 50 men or fraction thereof;
1 shower stall for each 20 men or fraction thereof.

The above minimum requirements should be modified to meet various conditions and the class of employees to be accommodated. Where all the men begin and stop work at the same time, it is essential to provide more wash facilities than the minimum required. If the men go home at the close of each work day, it is possible that the shower stall requirements may be reduced, or eliminated entirely. However, in the case of trainmen and enginemen, the minimum requirements should prove adequate.

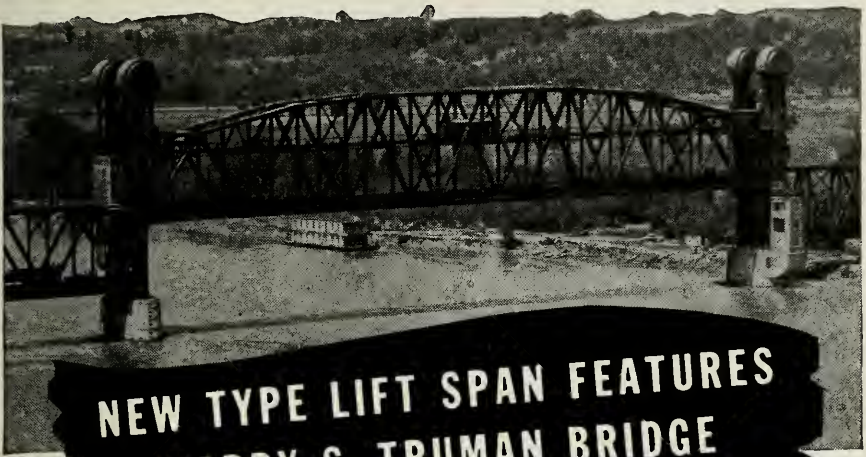
Wash facilities—The designer may select individual bowls, the trough type, or the circular wash fountain, but it may be advisable to consult local representatives of the employees as to what type is preferred. With the individual bowl, each user can temper the wash water to suit himself. Some codes prohibit the use of stoppers with individual bowls, as they are usually left in an unsanitary condition when stoppers are used. The wash trough seems to be ideal for most installations. Such troughs are single or double; the single for wall-hung installations, and the double for free standing installations. Hot and cold water lines join at a single spigot and the running water can be tempered to the degree desired by the individual. The circular and semi-circular wash fountains have come into use within the last decade or so. These fountains are mounted on a single pedestal and are constructed of concrete with aggregates of various colors and textures. In recent years stainless steel has also been used for fabricating such wash fountains.

These fountains are particularly adapted to installations where many men wash at the same time. The flow of water is usually controlled by a foot-operated valve which, in turn, is operated by a metal ring just above floor level. This ring may be divided into four sections, each section controlling the flow of water to one-fourth of the fountain. The cold and hot water supplies lead to a mixing valve where the temperature of the wash water is controlled. The water is discharged in a heavy spray and is of the same temperature for all users of the facilities.

Water closets—The bowls of water closets should be of the elongated type; in fact, many codes require this type of bowl. Seats with open fronts and no covers should be used. Plastic seats are preferable, and, if deemed necessary for any particular installation, they may be of the self-rising type. Closets, equipped with flush valves and vacuum breakers, are preferable to the low-down flush tanks or high tanks. Flush valves require at least one-inch supply lines and 15 lb. water pressure. Where adequate pressure is not available, flush tanks must be used, and, if the low-down type, it is desirable to provide them with lock-on covers.

Urinals — Floor-type urinals, with automatic flushing device, are usually preferable. They need not be more than 18 in. in width, and, if in batteries, should be placed on 24-in. centers. It is common practice to slope the floor of the toilet room toward floor type

THE 1,600-TON, 420-foot long lift span in its raised position provides a channel width of 400 feet and a vertical clearance above low water of 70 feet for navigation. The bridge consists of three 250-ft. through truss spans, one 420-ft. through truss vertical lift span, 18 deck plate girder spans of 78 feet and one plate girder span of 45 feet. It was designed and the construction supervised by Howard, Needles, Tammen & Bergendoff, consulting engineers.



NEW TYPE LIFT SPAN FEATURES HARRY S. TRUMAN BRIDGE

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This imposing bridge is a single track structure with a total length of 2,633 feet. Its dominating 420-foot vertical lift span over the navigation channel is electrically operated by remote control from a 3-story operating house located on one of the end piers. A gasoline power unit is available for emergency operation.

The unusual features and engineering developments which are embodied in the design and construction of the Harry S. Truman Bridge, contribute to the lasting strength and ruggedness demanded by today's and tomorrow's heavy freight tonnage, great traffic density, and high speed operations. The completed ready-for-traffic superstructure was under contract to American Bridge Company.

Projects such as this point the way to the problems now facing America's railroads—for "better railroading" is here to stay. And as your new plans of roadbed rehabilitation shape up, American Bridge Company will be prepared to meet your every structural need.

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urinals in order to eliminate the necessity of floor drains. Wall hung or pedestal-type urinals are satisfactory and are preferred to the floor type in some localities. The trough-type urinal may be suitable in certain instances. If used, proper metal shields must be used and placed on 24-in. centers. This type urinal is not as sanitary as the other types and is seldom used in new work.

Shower stalls—Shower stalls can be obtained as a unit, complete with integral base, drain, shower heads, supplies, etc., and this type is preferable. The stall should not be less than 36 in. by 36 in. by 72 in. high. In addition to the shower stall, it is necessary to provide a dressing compartment adjoining the shower stall, of the same height and width, and at least 42 in. long. A small seat or bench is usually placed in the dressing compartment. Curtain rods, canvas curtains, etc., should be provided for both the shower stall and the dressing compartment.

Drinking fountains—A drinking fountain must be installed in each locker room—not in the toilet or wash room. This facility should be placed on a wall adjacent to the wash room so as to minimize the amount of plumbing work. Only drinking fountains of the angle-stream type should be considered.

Toilet stalls—It is best to provide metal toilet stalls, complete with all appurtenances, such as door latches, coat hooks, paper holders, etc. In the more important installations, structural glass, marble or enamelware might be used, and, where such are used the doors should be of wood or metal to provide a more suitable material for the application of hardware. Stalls should be not less than three feet wide by five feet long, and not more than six feet high. The bottoms of side panels and doors should be set about one foot above the floor level in order to facilitate the mopping and cleaning of floors.

Lockers—All lockers should be constructed of metal and equipped with hat shelf, hanger bar, coat hooks, and provision for padlocking. Lockers are usually constructed with legs 6 in. high, and can be obtained with sloping tops, which discourages the placing or storage there of various articles.

The size of the lockers may vary considerably, and depends upon the class of employees to be accommodated and the state in which the facility is located. Some railroads standardize on the maximum size required by any code in their territory. This is so the lockers can be used on any part of the system, and at the same time show no discrimination.

Steel lockers should be ordered in groups in order to save metal and reduce cost. However, the grouping should not include too many lockers, *i.e.*, not more than three, four or five openings wide. The groupings can be single face or double face, and one should specify when ordering. It is customary to ship metal lockers "knocked-down" to save shipping space and to facilitate placing them in rooms.

Water Service

The water supplied for use in welfare buildings must be potable—that is, fit for human consumption. In most cases, municipal water service is available; however, in some isolated localities a well must be drilled and the state health authorities will require certain tests before certifying it as an approved well.

It is necessary to furnish an adequate supply of hot and cold water to the various fixtures. Cold water presents no problem, and hot water can be provided in various ways. If steam is available the year round, hot water can be made through the use of a steel storage tank fitted with heating coils. Should the building have its own heating plant, hot water can be made through an indirect heater, coils or other fitting in the fire box. Of course, this is only during the heating season. For the summer months, an auxiliary small hot water heating boiler can be installed.

It is always a source of annoyance as to who shall fire the boiler to provide hot water. Therefore, it is well to consider the installation of an oil-fired plant for heating hot water. If gas is available, the installation of a gas-fired hot water heater and storage tank may be considered. It is an ideal arrangement and well worth the additional cost of operation. Where only small storage quantities of hot water are required, electric hot water heaters are suitable.

Sewage Disposal

In most instances municipal sanitary sewers are available for sewage disposal. Where they are not, a septic tank must be installed. Septic tanks are satisfactory and require very little attention if properly installed. The effluent can be discharged into a dry-well, or through a system of farm drain tile.

The foregoing report covers general principles which are consistent with good practice. Each proposal must receive individual consideration, and the

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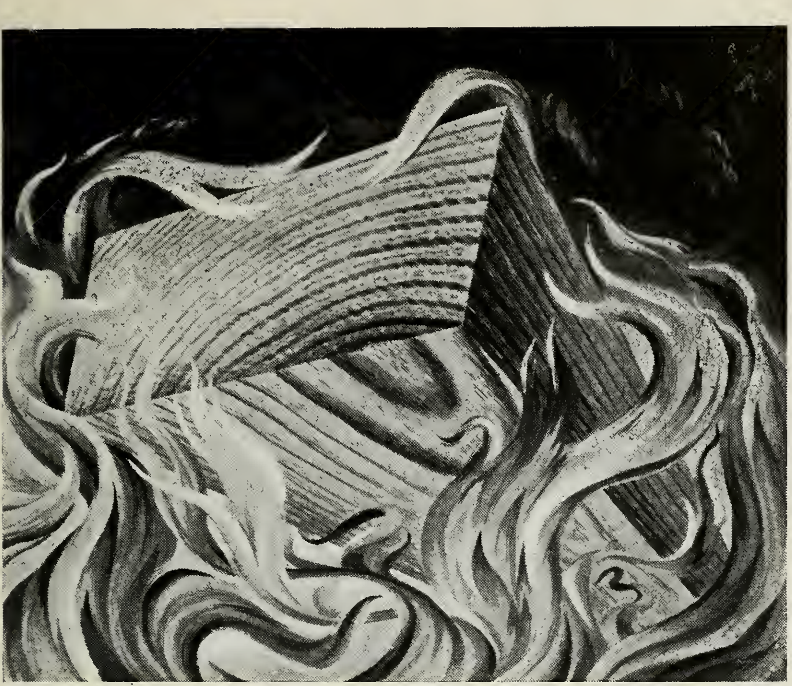
installation made should satisfy the personnel involved.

DISCUSSION

In replay to a question from E. R. Schlaf (I.C.), Chairman Winkelhaus stated that where sink stoppers are not used it is not always customary to install mixing faucets. W. A. Huckstep (M.P.) said that temperature-control regulators, set for 115 deg. F., were always used with mixing faucets on his road to preclude the possibility of persons being burned.

Commenting on that part of the report which stated that it is good practice to apply hard cement plaster to the lower seven feet of walls in toilet rooms, W. C. Harmon (S.P.) stated that he preferred to use a ceramic wainscoting to about the same height.



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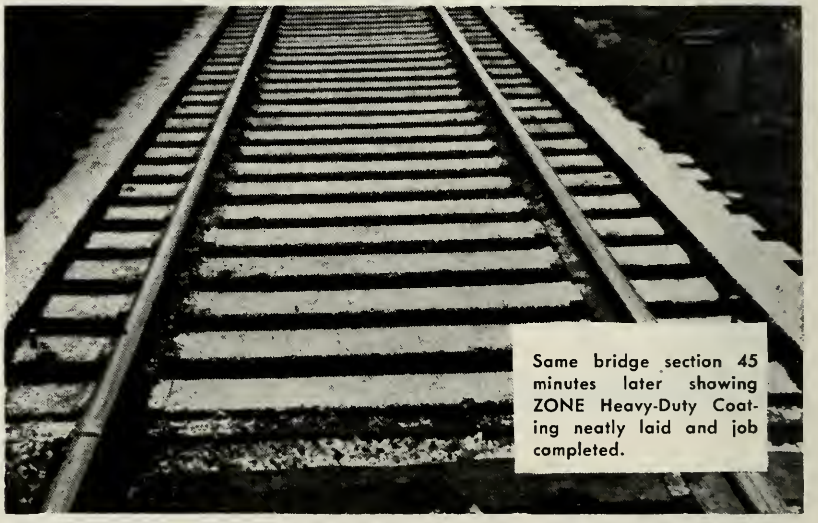

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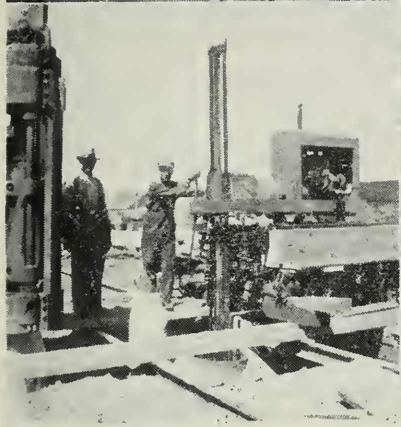

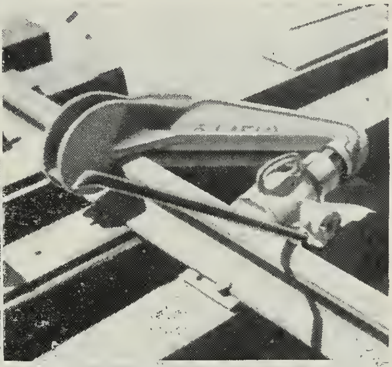

• **ABOVE:** BUDA Earth Drill, highly efficient unit for all types of bridge and construction work. Model HBD shown, is pre-boring for piling on a typical bridge job.

• **RIGHT:** BUDA Klinch-Klaw Jack, ideal for pulling bolts and spikes from bridges and trestles.

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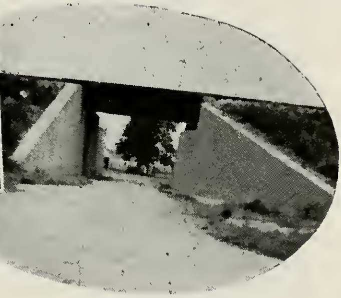
Condition of Bridge Wing Walls before starting work



After Restoration Service

Note condition of disintegrated concrete Wing Wall at left

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Let a Detzel Engineer Help You...

with Your Masonry Maintenance Problems

Write for further information

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	1942-1943	1943-1944	1944-1945	1945-1946
President	G. S. Crites	J. L. Varker	J. L. Varker	N. D. Howard
1st V.-Pres.	R. E. Caudle	R. E. Caudle	R. E. Caudle	F. G. Campbell
2nd V.-Pres.	A. M. Knowles	N. D. Howard	N. D. Howard	J. S. Hancock
3rd V.-Pres.	N. D. Howard	F. G. Campbell	F. G. Campbell	E. H. Barnhart
4th V.-Pres.	J. L. Varker	J. S. Hancock	J. S. Hancock	W. F. Martens
Secretary	A. G. Shaver† Lorene Kindred‡ Elinor V. Heffern	Elinor V. Heffern	Elise LaChance	Elise LaChance
Treasurer	F. E. Weise	C. R. Knowles	C. R. Knowles	C. R. Knowles
Treasurer Emeritus		F. E. Weise	F. E. Weise	
Directors	M. Meyer	W. F. Martens	W. F. Martens	A. B. Chapman
	L. E. Peyser	A. L. McCloy	A. L. McCloy	W. A. Huckstep
	K. L. Miner	L. C. Winkelhaus	L. C. Winkelhaus	F. R. Spofford
	F. G. Campbell	E. H. Barnhart	E. H. Barnhart	Guy E. Martin
	J. S. Hancock	A. B. Chapman	A. B. Chapman	B. R. Meyers
	L. C. Winkelhaus	L. E. Peyser	L. E. Peyser	L. E. Peyser

	1946-1947	1947-1948		
President	F. G. Campbell	J. S. Hancock		
1st V.-Pres.	J. S. Hancock	E. H. Barnhart		
2nd V.-Pres.	E. H. Barnhart	W. F. Martins		
3rd V.-Pres.	W. F. Martens	W. A. Huckstep		
4th V.-Pres.	W. A. Huckstep	G. E. Martin		
Secretary	Elise LaChance	Elise LaChance		
Treasurer	C. R. Knowles	C. R. Knowles*		
Directors	Guy E. Martin	H. M. Harlow		
	B. R. Meyers	H B. Christianson		
	L. E. Peyser	F. R. Spofford		
	H. M. Harlow	Lee Mayfield		
	H. B. Christianson	Franz M. Misch		
	F. R. Spofford	W. D. Gibson		

†To November 1, 1942
‡To February 1, 1943

*Died Aug. 6, 1948

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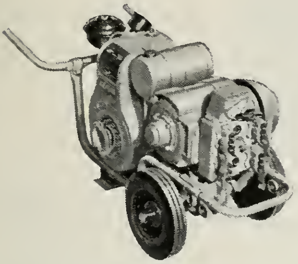

Model M-2 Portable Power Plant, 2.5 KVA capacity, is shown above. Other models 1.25 and 5 KVA capacities are also available.

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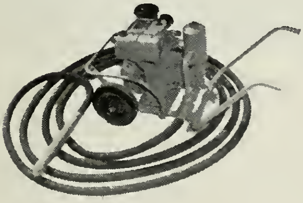
With Permanent-Magnet Generators

Generators that require no maintenance, no adjustment; that are absolutely trouble-proof and produce BOTH single-phase and 3-phase 60 cycle 110 volt AC to full rated capacity. These plants are powered by husky Wisconsin gas engines and have proved their outstanding reliability throughout the railway field.



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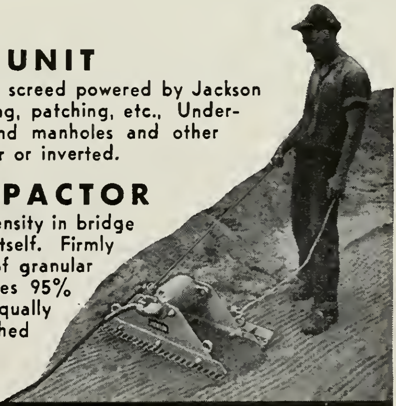
JACKSON PAVING UNIT

Consists of a manually guided vibratory screed powered by Jackson portable power plant. Perfect for paving, patching, etc., Undercuts at side forms — works right around manholes and other obstructions — strikes off crowns, regular or inverted.

JACKSON SOIL COMPACTOR

Quickly and easily provides maximum density in bridge approaches and similar fills. Propels itself. Firmly compacts 10 to 15 sq. ft. per minute of granular soil to a depth of 12 inches. Produces 95% maximum density in a single pass. Equally adaptable to coarse gravel and crushed rock. Write for details.



ELECTRIC TAMPER & EQUIPMENT CO.
LUDINGTON MICHIGAN

CONSTITUTION

ARTICLE I.

NAME

Section 1. This association shall be known as the American Railway Bridge & Building Association.

ARTICLE II.

OBJECT

Section 1.** The object of this association shall be the advancement of knowledge pertaining to the design, construction and maintenance of railway bridges, buildings, water service facilities, and other structures, by investigation, reports and discussions.

Section 2. The association shall neither indorse nor recommend any particular devices, trade marks or materials, nor will it be responsible for any opinions expressed in papers, reports or discussions unless the same have received the endorsement of the association in regular session.

ARTICLE III.

MEMBERSHIP

Section 1. The membership of this association shall be divided into five classes, viz: Members, life members, associate, honorary and junior members.*

Section 2.** A member shall be a person in a position above rank of gang foreman in connection with railway bridge, building and water service work. Any person desirous of becoming a member shall make application upon the form prescribed by the executive committee, setting forth his name, age, residence and practical experience. He shall furnish at least three references to whom he is personally known. Applicants may be voted into membership at any regular executive meeting or by letter ballot of the executive committee, a majority vote being necessary in either instance.

Section 3.** To be eligible for a life membership a member must have belonged to the association for at least twenty years and in general must have retired from active railway service due to age or physical disability. He shall have all the privileges of active membership, except the holding of office, and shall not be required to pay annual dues. The transfer from membership to life membership shall be made in the same manner as the election of members, as prescribed in Section 2, of this Article.

Section 4. Associates shall be responsible persons who are not eligible as members, whose pursuits or attainments qualify them to co-operate with members in the study and development of improved practices in the construction and maintenance of bridges, buildings and water facilities. They shall have all the rights of members except of voting and holding office. They shall be elected in the manner prescribed for members, in Section 2, of this Article.

Section 5. Honorary members shall be chosen from persons who have attained acknowledged eminence in some branch of engineering or railway service. Their number shall be limited to ten. Honorary members shall be proposed by not less than six active members and shall be elected by the unanimous vote of the members present at a regular meeting. They shall have all the rights of active members except that of holding office and shall be exempt from the payment of dues.

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*Amended October 16, 1941.
**Amended September 20, 1948.

Long railroad bridge before and after extensive repairs by the B. J. Many Company, Inc.

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MATERIALS

- **IN-FIL-TRO Depth Finish, an exclusive B. J. Many Company Inc. system.**
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NEVER, in nearly half a century of extensive research has there been discovered proven methods and materials that provide a more thorough and enduring job of

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Upon request, without obligation on your part, a trained B. J. Many Company, Inc. engineer will inspect your bridges and other structures and submit a detailed report of his findings with recommendations.

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WINNIPEG, MANITOBA — Northland Machinery Supply Co., Ltd.

Section 6. A junior member shall be a person who is a graduate of a recognized engineering school, or who has been employed for at least two years in the design, maintenance or construction of railway bridges, buildings or structures. Applicants shall be at least 21 years of age and they shall be elected in the manner prescribed for members, in Section 2 of this article. Juniors shall have all the rights of members except that of holding office. When the attainments of a Junior are such as to qualify him as a member, he may apply for promotion and the Executive Committee shall authorize such promotion when qualifications warrant the action. Unless a Junior is promoted, his membership shall cease automatically when he becomes 28 years of age.*

Section 7. Any member guilty of conduct unbecoming a railroad officer and a member of this association, or who shall refuse to comply with the rules of this association, shall forfeit his membership on a two-thirds vote of the executive committee.

Section 8. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled, or dropped for non-payment of dues in accordance with Section 1 of Article VII.

Section 9.** Only active members shall hold office in this association, and only active and life members shall be entitled to vote in the election of officers.

ARTICLE IV.

OFFICERS

Section 1. The officers of this association shall be a president, four vice-presidents, a secretary, a treasurer and six directors who with the most recent past president shall constitute the executive committee.

Section 2. The past presidents of this association, previous to the most recent past president, who continue to be members, shall be privileged to attend all meetings of the executive committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past presidents shall not have a right to vote, unless called upon to fill a quorum.

Section 3. Vacancies in any office shall be filled for the unexpired term by the executive committee without delay.

ARTICLE V.

EXECUTIVE COMMITTEE

Section 1.** The executive committee shall manage the affairs of the association and shall have full power to control and regulate all matters not otherwise provided for in the constitution and by-laws and shall exercise general supervision over the financial interests of the association, and make all necessary purchases and contracts required to conduct the general business of the association but shall not have the power to render the association liable for any debt beyond the amount then in the treasury plus accounts rceivable and not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the association.

Section 2. Meetings of the executive committee may be called by a majority of the members of the committee, providing 10 days' notice is given members by mail.

Section 3. Five members of the executive committee shall constitute a quorum for the transaction of business.

ARTICLE VI.

ELECTION OF OFFICERS AND TENURE OF OFFICE

Section 1. Except as otherwise provided the officers shall be elected at the regular annual meeting of the association and the election shall not be postponed except by unanimous consent of the members present at said annual meeting. The election shall be by ballot, a majority of the votes cast being required for election. Any active member of the association not in arrears for dues shall be eligible for office, but the president shall not be eligible for reëlection.

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*Amended October 16, 1941.

**Amended September 20, 1948.

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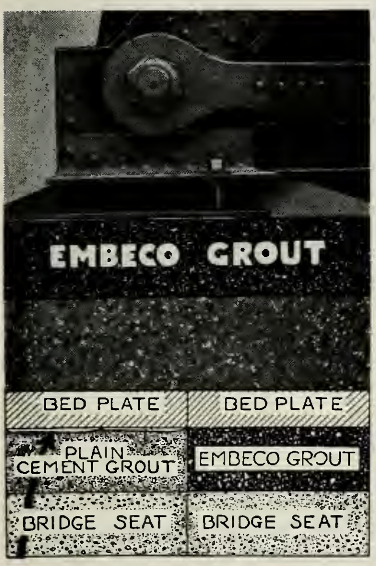

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Section 2.† The president, four vice-presidents, secretary and treasurer shall hold office for one year and the directors for two years, three directors being elected each year. All officers retain their offices until their successors are elected and installed.

Section 3.† The term of office of the secretary and the treasurer may be terminated at any time by a two-thirds vote of the executive committee. Their compensation shall be fixed by a majority vote of the executive committee.

The secretary shall also serve as secretary of the executive committee.

Section 4. The secretary and the treasurer shall be required to give bond in an amount to be fixed by the executive committee.

ARTICLE VII.

MEMBERSHIP FEE AND DUES

Section 1.† Every member upon joining this association shall pay to the secretary an entrance fee and dues as prescribed by the executive committee. No member in arrears for annual dues shall be entitled to vote at any election and any member more than one year in arrears may be stricken from the list of members at the discretion of the executive committee.

ARTICLE VIII.*

LOCAL SECTIONS

Section 1.** Upon the application of ten or more members of the association residing in the same geographical district, or having offices therein, the executive committee shall organize a local section for that district, to which all members in that district shall be eligible. Such local section shall admit to active membership only members in good standing. It shall hold not less than two meetings each year, and shall be governed by such constitution and by-laws not inconsistent with the constitution of this association as the section membership may adopt and the executive committee of the association approve.

Section 2. The parent association shall not be put under any obligation, either financial or in the matter of policy or opinion, by any local section.

ARTICLE IX.

AMENDMENTS

Section 1. This constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that notice of the proposed amendment or amendments has been sent to the members at least 30 days previous to said regular meeting.

BY-LAWS

TIME OF MEETING

1.** The regular meeting of this association shall convene annually during the month of September, the exact date to be fixed by the Executive Committee.

PLACE OF MEETING

2.** The place of holding the annual convention shall be Chicago, Ill.

3. It shall lie within the power of the executive committee to change the location or time of the meeting if it becomes apparent that it is for the best interests of the association.

QUORUM

4. At the regular meeting of the association, 15 or more members shall constitute a quorum.

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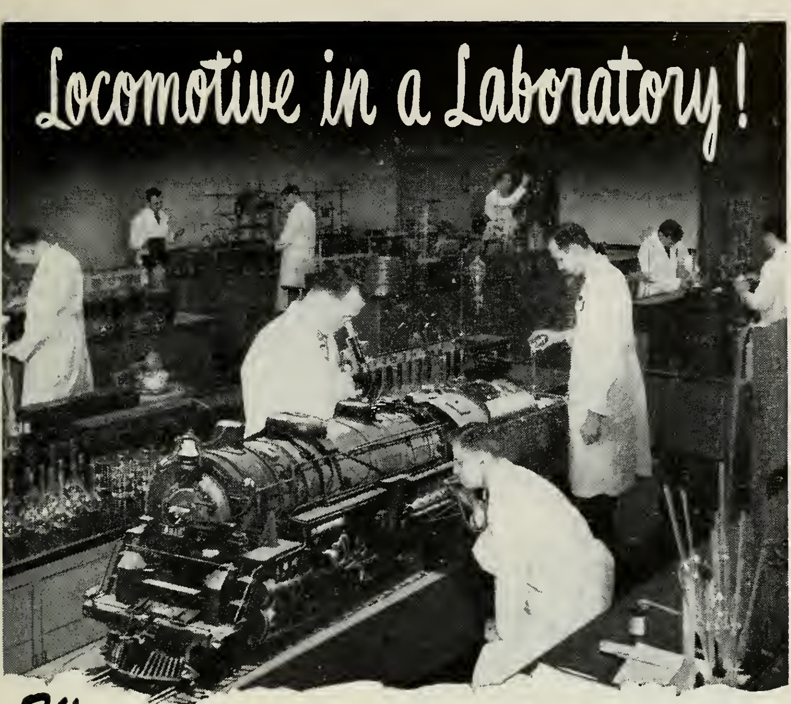
†Amended October 17, 1940.

*Article adopted 1922.

**Amended September 20, 1948.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The Complete System of
Locomotive Water Treatment

Nalco

**DUES

5. The annual dues, for the fiscal year ending August 31, and payable in advance, shall be as follows:*

Members, $5.00; Associate Members, $4.00; Junior Members, $2.50.

DUTIES OF OFFICERS

6.† The president shall have general supervision over the affairs of the association. He shall preside at all meetings of the association and of the executive committee; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. He shall with the secretary sign all contracts or other written obligations of the association which have been approved by the executive committee. He shall render a detailed report at least three times during the year to the members of the executive committee, showing the financial condition of the association and its activities.

At the annual meeting the president shall present a report containing a statement of the general conditions of the association.

7. The vice-presidents in order of seniority shall preside at meetings in the absence of the president and discharge his duties in case of a vacancy in his office.

8.† It shall be the duty of the secretary to keep a correct record of the proceedings of all meetings of this association, and of all accounts between this association and its members; to collect all moneys due the association, and deposit the same in the name of the association. He shall pay all bills when properly certified and approved by the president and the treasurer, and make such reports as may be called for by the executive committee. He shall also perform such other duties as the association may require.

9.‡ The treasurer shall have charge of the funds, check all deposits as made by the secretary, sign all checks after they have been approved by the president, and invest all funds not needed for current expenses as directed by the executive committee. He shall report at each annual meeting on the condition of the finances.

NOMINATING COMMITTEE

10. After each annual meeting the president shall appoint a committee of five members, not officers of the association, of whom two at least shall be past presidents, and two of whom shall have served on the committee the previous year, which shall prepare a list of names of nominees for officers to be voted on at the next annual convention, in accordance with Article VI of the constitution, said list to be read at the first session of the second day of said convention. Nothing in this section shall be construed to prevent any member making further nominations.

AUDITING COMMITTEE

11.‡ Prior to each annual meeting the president shall appoint a committee of three members, not officers of the association, whose duty it shall be to examine the accounts and vouchers of the secretary and the treasurer and certify as to the correctness of their accounts.

COMMITTEE ON SUBJECTS FOR DISCUSSION

12. After each annual meeting the president shall appoint a committee whose duty it shall be to prepare a list of subjects for investigation to be submitted for approval at the next convention.

COMMITTEE ON INVESTIGATION

13. After the association has adopted the list of subjects for investigation the president for the succeeding year shall appoint the committees who shall prepare the subjects for report and discussion. He may also appoint individual members to prepare reports on special subjects, or to report on any special or particular subject.

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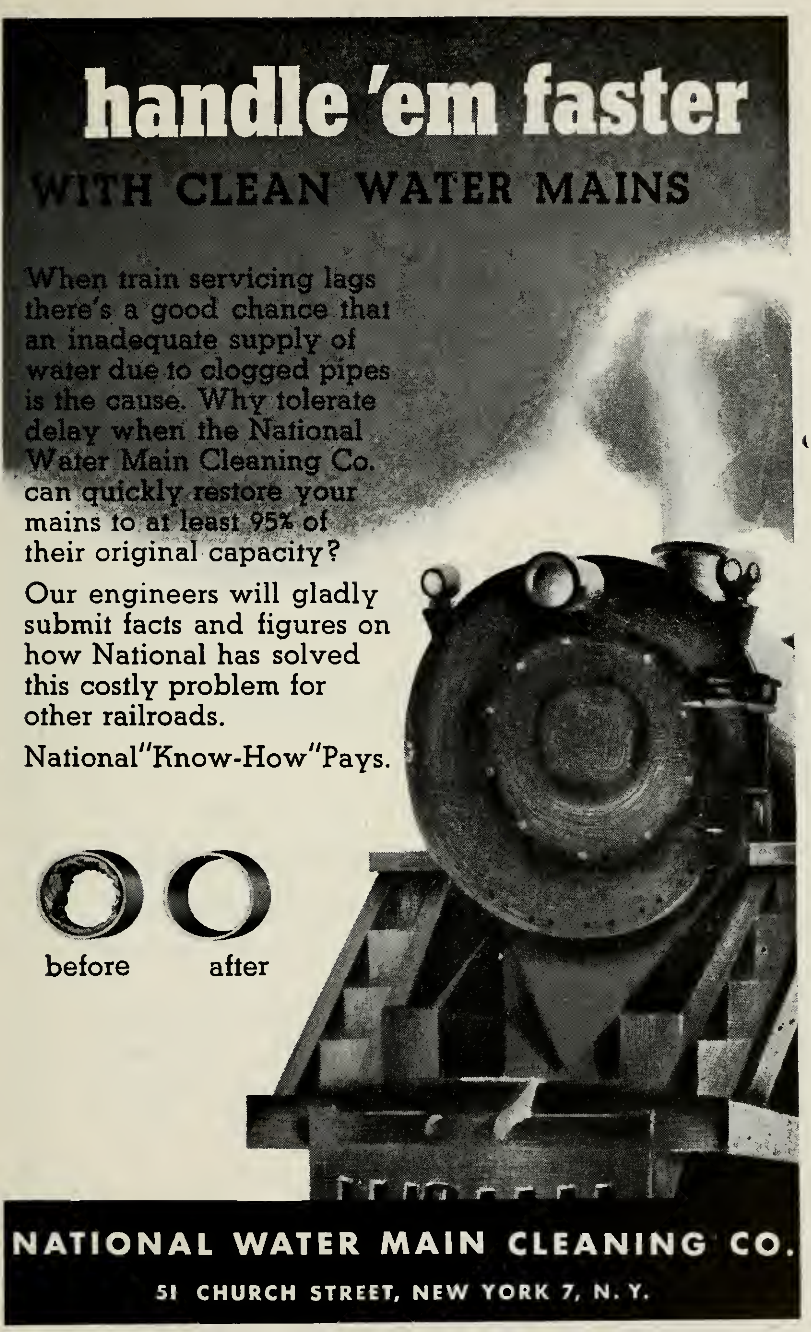
*Amended October 16, 1941.
‡Amended October 17, 1940.
†Adopted October 17, 1940.
**Amended September 20, 1948.



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PUBLICATION COMMITTEE

14. After each annual meeting the executive committee shall appoint a publication committee consisting of three active members whose duty it shall be to coöperate with the secretary in the issuing of the publications of the association. The assignment of this committee shall be such that at least one member shall have served on the committee during the previous year.

ORDER OF BUSINESS

15.† Call to order by president.
Opening prayer or invocation.
President's address.
Report of secretary.
Report of treasurer.
Appointment of special committees.
Reports of standing committees and presentation of papers.
Unfinished business.
New business.
Election of officers.
Installation of officers.
Adjournment.

DECISIONS

16. The votes of a majority of the members present shall decide any questions, motion or resolution which shall be brought before the association, unless otherwise provided. Unless specifically provided herein otherwise all discussions shall be governed by Robert's rules of order.

AMENDMENTS

17.† The By-Laws can be amended by a two-thirds vote of those present at any regularly called Executive Committee Meeting.

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†Amended September 20, 1948

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DIRECTORY OF MEMBERS

as of March 1, 1949

(Figure after each name indicates year when member joined association.)

ACTIVE MEMBERS

H. C. **Aaron**, Supv. B. & B., W. M. R. R., Hagerstown, Md., (1935).
L. F. **Abrams**, Supv. W. S., I. C. R. R., Fort Dodge, Ia., (1947)
A. F. **Ainslie**, Supv. B. & B., N. P. Ry., Spokane, Wash., (1948).
H. J. **Aliberti**, Asst. Supv. B. & B., Me. C. Ry., Portland, Me., (1947)
G. A. **Allen**, Br. Insp., C. & O. Ry., Clifton Forge, Va., (1940).
W. V. **Allen**, Asst. Supv. B. & B., C. & O. Ry., Catlettsburg, Ky., (1946).
A. **Anderson**, Sp. Asst. Engr., N. Y. C. R. R., Chicago, (1947)
J. L. **Anderson**, Sup. B. & B., Mo. Pac. R. R., Osawatomie, Kans., (1931)
J. T. **Andrews**, Asst. Engr., B. & O. R. R., Baltimore, Md., (1947)
W. F. **Armstrong**, Arch. Dftsmn., C. & N. W. Ry., Chicago, (1947)
L. K. **Arnold**, Div. Br. Insp., A. T. & S. F. Ry., San Bernardino, Calif., (1944).
T. J. **Atkinson**, Mast. Carp., Penn. R. R., Chicago, (1947)
S. K. **Autrey**, B. & B. & W. S. Insp., Burlington-Rock Island, Teague, Tex.

J. H. **Babbitt**, Asst. Div. Eng., B. & O. R. R., Indianapolis, Ind., (1946).
R. C. **Baker**, B. & B. Supv. C & E. I. Ry., Danville, Ill., (1940)
E. H. **Barnhart**, Div. Engr., B. & O. R. R., Garrett, Ind., (1941).
H. L. **Barr**, Div. Engr., C & N. W. Ry., Boone, Ia., (1938)
G. J. **Bass**, Gen. For., B. B. & W. S., G. C. & S. F. Ry., Galveston, Tex., (1946).
W. A. **Batey**, (Retired) Constr. Engr., U. P. R. R., Alhambra, Calif., (1913).
Y. C. **Beam**, Asst. Mast. Carp., S. A. L. Ry., Americus, Ga., (1945).
A. E. **Bechtelheimer**, (Retired) Engr. of Br., C. & N W. Ry., Chicago, (1920)
W. H. **Begeman**, B. & B. Supvr., Mo. Pac. R. R., Jefferson City, Mo., (1941).
J. G. **Begley**, Div. Engr., B. & O. R. R., Washington, Ind., (1946).
H. I. **Benjamin**, Vice-Chair. Sys., Com. on Ins., So. Pac. Ry., San Francisco, Cal., (1922).
G. W. **Benson**, Supvr. B. & B., C. of G. Ry., Macon, Ga., (1940).
M. A. **Beringer**, Br. Insp., I. C. R. R., Chicago, (1929).
C. E. **Bingaman**, Mast. Carp., Reading Co., Tamaqua, Pa., (1948).
H. F. **Bird**, Supv. B. & B., N. Y. C. Sys., Syracuse, N. Y., (1937).
R. D. **Bisbee**, Div. Engr., A. T. & S. F. Ry., Slaton, Tex., (1947).
O. H. **Blankenship**, W. S. For., M. P. R. R., Poplar Bluff, Mo., (1948).
E. H. **Blewer**, Supv. Saf. Engr., N. Y. C. Sys., New York, (1937).
M. **Block**, Engr. of Bridges, I. C. R. R., Chicago, (1948).
H. **Bober**, B. & B. Engr., G. M. & O. R. R., Mobile, Ala., (1947).
H. A. **Boehling, Jr.**, Asst. Cost Engr., C. & O. Ry., Richmond, Va., (1948).
W. C. **Borchert**, Div. Engr., L. & A. Ry., Shreveport, La., (1942).
M. A. **Bost**, Asst. Engr., C. M. St. P. & P. R. R., Mason City, Iowa, (1935).
L. E. **Bowers**, Supv. B. & B., C. of G. R. R., Opelika, Ala., (1947)
J. J. **Brandimarte, Jr.**, Asst. Mast. Carp., Penn. R. R., Harrisburg, Pa., (1947).
R. H. **Brandt**, Mast. Carp., C. B. & Q. R. R., Galesburg, Ill., (1946).
I. C. **Brewer**, Div. Engr., C. M. St. P. & P. R. R., Milwaukee, Wis., (1947)
W. T. **Brice**, B. & B. Master, C. N. R., Regina, Sask., Can., (1946).
E. J. **Brown**, Engr. of Track, C. B. & Q. R. R., Chicago, (1947)
T. W. **Brown**, Chf. Water Chem., I. C. R. R., Chicago (1947)
R. J. **Bruce**, Asst. Engr., Mo.-Ill. R. R., Bonne Terre, Mo., (1946).
W. O. **Bruce**, Spl. Repr. to Vice-Pres. (Oper.), C. R. I. & P. R. R., Chicago, (1948).
F. N. **Budzenski**, Asst. Supv. B. & B., C. & N. W. Ry., Antigo, Wis., (1938).
H. M. **Buell**, Bridge Insp. U. P. R. R., Omaha, Nebr., (1937).
W. H. **Bunge**, Asst. Engr., M. P. Lines, Houston, Tex., (1941).
E. E. **Burch**, Asst. Br. Engr., C. M. St. P. & P. Ry., Chicago (1945)
A. E. **Burford**, Gen. For. B. & B., I. C. R. R., Memphis, Tenn., (1947)
W. R. **Burke**, B. & B. Supv., I. C. R. R., Champaign, Ill., (1947)
A. L. **Burleson**, B. & B. Insp. (St. L.-S. F. Ry., Memphis, Tenn., (1947)
C. M. **Burpee**, V.-P. Simmons-Boardman Pub. Corp., New York, (1930).
C. D. **Burrows**, Mast. Carp., B. & O. R. R., Wilmington, Del., (1946).

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W. W. Caines, Asst. Supv. B. & B., C. & O. Ry., Huntington, W. Va., (1938).
F. G. Campbell, Ch. Engr., E. J. & E. Ry., Joliet, Ill., (1936).
J. P. Canty, Asst. to Engr. M. of W., B. & M. R. R., Boston, Mass., (1901).
J. G. Carlon, Asst. Supv. B. & B., C. & O. Ry., Russell, Ky., (1947)
M. D. Carothers, Ch. Engr., G. M. & O. R. R., Bloomington, Ill., (1938).
R. B. Carruthers, Br. Engr., T. & N. O. Ry., (S. P. Lines), Houston, Tex., (1946)
J. W. Carter, B. & B. Supv., Vir. Ry. Co., Roanoke, Va., (1947)
R. E. Caudle, Asst. Engr. Str., M. P. Lines, Houston, Tex., (1921).
T. M. Cawthon, Asst. B. & B. Supv., S. P. Co., Martinez, Calif., (1943).
P. C. Chamberlain, Asst. Engr., Erie R. R., Cleveland, Ohio, (1941)
A. B. Chaney, Asst. Engr. M. of W., Mo. Pac. Lines, St. Louis, Mo., (1947)
S. L. Chapin, Saf. Supv., So. Pac. Co., San Francisco, Calif., (1946).
A. B. Chapman, Asst. Chief Engr., C. M. St. P. & P. R. R., Chicago, (1938).
A. Chinn, Pres., Term. R. R. Assoc. of St. L., St. Louis, Mo., (1930).
L. Christiansen, B. & B. Fore., C. M. St. P. & P. Ry., Marion, Ia., (1928)
H. B. Christianson, Prin. Asst. Engr., C. M. St. P. & P. Ry., Chicago, (1928).
C. M. Chumley, Engr. M. of W., I. C. R. R., Chicago, (1947)
M. A. Clancy, Gen. Steel Fore., D. & H. R. R., Green Island, N. Y., (1942).
L. Clapper, Ch. Engr., D. M. & I. R. Ry., Duluth, Minn., (1919).
K. L. Clark, Div. Engr., C. M. St. P. & P. R. R., Chicago (1939)
W. P. Clark, Supv. B. & B., L. V. R. R., Wilkes-Barre, Pa., (1944).
E. J. Clopton, Div. Engr., B. & O. R. R., Cumberland, Md. (1944).
G. W. Cobb, Asst. B. & B. Supv., So Pac. Co., Sparks, Nev. (1948).
G. V. Coffey, Supv. B. & B., M. C. R. R., Jackson, Mich., (1941).
P. B. Collier, Supv. B. & B., M. P. R. R., St. Louis, Mo., (1938).
R. L. Collum, Mast. Carp., S. A. L. Ry., Jacksonville, Fla., (1941).
A. A. Colvin, Div. Engr., C. & N. W. Ry.. Norfolk, Nebr., (1937).
B. S. Converse, Div. Engr., C. & N. W. Ry., Sioux City, Ia., (1947)
D. W. Converse, Br. Engr., A. C. & Y. R. R., Akron, Ohio, (1940).
E. F. Cook, Water Serv. For., Mo. Pac. R. R., Little Rock, Ark., (1947)
B. Cooper, Br. Inspr. Mo. Pac. R. R.,DeQuincy, La., (1947)
A. E. Copeland, Mast. Carp., C. B. & Q. R. R., North LaCrosse, Wis., (1947)
C. O. Coverley, Sys. Arch., A. T. & S. F. Ry., Chicago, (1946).
L. A. Cowsert, W. Insp., B. & O. R. R., Dayton, Ohio, (1915).
R. P. Cox, Engr. of Power Plant, C. B. & Q. R. R., Chicago, (1947)
F. H. Cramer, Br. Engr., C. B. & Q. R. R., Chicago, (1927).
F. W. Creedle, Asst. Engr. of Mtce., C. & N. W. Ry., Chicago, (1942).
C. H. Crews, B. & B. Supv., I. C. R. R., Jackson, Tenn., (1947)
P. H. Croft, Div. Engr. I. C. R. R., Chicago, (1947)
M. Cronin, Asst. B. & B. Supv. So. Pac. Co., Tucson, Ariz., (1943)
W E Crounse, Supv. B. & B., D. & H. R. R., Carbondale, Pa., (1945).
J. W. Cummings, Supv. Wk. Eqpt., D. & H. R. R., Albany, N. Y., (1947)
C. P. Cummins, Asst. Engr., M. K. T. R. R., St. Louis, Mo., (1948).
H. D. Curie, Mast. Carp., B. & O. R. R., Garrett, Ind., (1942).

P. E. Dale, Supv. B. & B., N. Y. C. Sys., Indianapolis, Ind., 1947)
G. B. Davis, B. & B. Supv., N. Y. C. Sys., Columbus, Ohio, (1942)
L. H. Lewis, Gen. For. B. & B., A. T. & S. F. R. R., Amarillo, Tex., (1948).
H. E. Davis, B. & B. Supv., N. Y. C., Sys. Chicago, (1940).
R. DeArmond, Asst. B. & B. Supv., So. Pac. Co., San Francisco, Cal., (1938).
H. R. Demmon, Asst. Gen. B. & B. Insp., So. Pac. Co., Albany, Calif., (1948).
A. H. Deno, Supv., B. & B., C. & N. W. Ry., Green Bay, Wis., (1941).
L. J. Deno, Office Engr., C. & N. W. Ry., Chicago, (1947).
E. J. De Witt, Off. Engr., N. Y. O. & W. Ry., Middletown, N. Y., (1944).
H. M. Dick, Mast. Carp., Penn. R. R., Columbus, Ohio, (1942).
M. H. Dick, Man. Ed., Ry. Engr. & Mtce., Chicago, (1937).
Fred Dodson, Asst. Supv. B. & B., C. & O. R. R., Covington, Ky., (1948).
A. G. Dorland, Asst. Engr., E. J. & E. Ry., Joliet, Ill., (1941).
J. L. Dougherty, Supv. B. & B., W. M. Ry., Cumberland, Md., (1944).
R. E. Dove, Man. Ed., Ry. Engr. & Mtce. Cycl., Chicago, (1934).
J. A. Doyle, B. & B. Master, D. & H. R. R., Corp., Carbondale, Pa., (1947)
C. R. DuBose, Res. Engr., Mo. Pac. R. R., Houston, Tex., (1948).
J. V. Duchac, Supv. B. & B., C. & N. W. Ry., Antigo, Wis., (1927).
J. P. Dunnagan, Engr. of Br., So. Pac. Co., San Francisco, Calif., (1943).
F. Duresky, Jr., Supv. B. & B., C. & N. W. Ry., Huron, So. Dak., (1942).
W. E. Dwy, Field Engr., B. & O. R. R., Pittsburgh, Pa., (1948).

J. Ebbens, Supv. B. & B., C. & W. I. R. R., Chicago, (1947).
C. M. Eichenlaub, Res. Engr., S. D. & A. E. Ry. Co., San Diego, Cal., (1943).
C. Eisele, Asst. Engr., N. Y. C. Sys., Chicago, (1930).
L. Elower, Traveling Br. Insp., Erie R. R., Owego, N. Y., (1948).
E. M. Enger, B. & B. Supt., C. St. P. M. & O. Ry., St. Paul, Minn., (1947)
V. E. Engman, Ch. Carp., C. M. St. P. & P. R. R., Savanna, Ill., (1920)

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L. I. Evans, Instmn., C. M. St. P. & P. R. R., Savanna, Ill., (1937).
H. E. Ezzell, Asst. Scale Supv. Mo. Pac. Lines, San Antonio, Tex., (1947)

C. U. Faircloth, Br. Inspr., I.-G. N. R. R. (Mo. Pac.), Palestine, Tex., (1947).
E L. Farmer, Rdm., St. L. S. W. Ry., Lewisville, Ark., (1946).
C. Fest, Asst. B. & B. Supv., So. Pac. Co., Milwaukie, Ore., (1948).
L. M. Firehammer, Gen. Supv. B. & B., Ill. Term. R. R., Springfield, Ill., (1919).
G. R. Fisher, B. & B. Master, Ca. Nat. R. R., Stratford, Ont., Canada, (1948).
E. E. Foster, Asst. Engr., M. St. P. & S. S. M. R. R., Stevens Point, Wis., (1947)
K. Fousts, Gen. For. B. & B. & W. S., St. L. S. F. R. R., Chaffee, Mo., (1948).
R. L. Fox, Div. Engr., So Ry., Alexandria, Va., (1935)
W. H. Freeman, B. & B. Supv., C. G. W. Ry., Oelwein, Iowa, (1946).
C. G. Friets, Supv. B. & B., C. & N. W. Ry., Escanaba, Mich., (1938).
L M. Frost, Supv. B. & B., G. T. W. Ry., Battle Creek, Mich., (1938).
W. E. Fuhr, Div. Engr., C M. St. P. & P. R. R., Ottumwa, Ia., (1948).
B. J. Furniss, B. & B. Supv., N. Y., N. H. & H. R. R., Hartford, Conn., (1946).

C. W. Gabrio, Br. Engr., Virginian Ry., Norfolk, Va., (1947)
J. Galbraith, B. & B. Supv., N. Y. C. R. R., New York, N. Y., (1947)
F. E. Galvin, Chief Carp., C. M. St. P. & P. R. R., La Crosse, Wis., (1948).
J. P. Gannon, Asst. Engr., M. St. P. & S. S. M. Ry., Stevens Point, Wis., (1947)
J. W. Gannon, Jr., Supv. B. & B., B. & M. R. R., Concord, N. H., (1948).
W. R. Ganser, Mast. Carp. Penn. R. R., Jersey City, N. J., (1931)
C. E. Garcelon, Supt. B. & B., B. & A. R. R., Houlton, Me., (1945).
L. D. Garis, Gen. Br. Inspr., C. & N. W. Ry., Chicago, (1930).
A. Gerske, Box 343, 1185 Hillcrest Blvd., Millbrae, Cal., (1938).
C. J. Geyer, Asst. Vice-Pres., C. & O. Ry., Richmond, Va., (1928).
W. D. Gibson, W. S. Engr., C. B. & Q. R. R., Chicago, (1946).
C. F. Gilbert, B. & B. Supv., C. & O. Ry., Peru, Ind., (1944).
J. M Giles, Asst. Eng. M. P. R. R., St. Louis, Mo., (1938).
W. G. Gillespie, Mast. Carp., B. & O. R. R., Grafton, W. Va., (1946).
A. D. Gillis, B. & B. Supv., N. Y., N. H. & H. R. R., Providence, R. I., (1923).
R. W. Gilmore, Gen. Br. Insp., B. & O. R. R., Cincinnati, Ohio, (1943).
F. M. Ginter, W. S. For., G. M. & O. Ry., Bloomington, Ill., (1939)
A. M. Glander, Ch. Carp., C. M. St. P. & P. Ry., Mason City, Iowa, (1936).
E. U. Gogl, Prin. Asst. B. & B. Supv., So Pac. Co., Hillsboro, Ore., (1948).
J. L. Gorrie, Asst. B. & B. Supv., So. Pac. Co., Eugene, Ore., (1948).
H. E. Graham, Asst. Supt. W. S., I. C. R. R., Chicago, (1946).
W. R. Graham, Asst. Supv. B. & B., C. & O. R. R., Erlanger, Ky., (1946).
H. P. Greene, Mast. Carp. Penn. R. R., Pittsburgh, Pa., (1947)
A. Guenther, Asst. Mast. Carp., C. B. & Q. R. R., Galesburg, Ill., (1947)
R. R. Gunderson, B. & B Supv., So. Ry. Co., Valdosta, Ga., (1947)
J. M. Gustafson, Br. Engr., Minn. & St. Louis Ry., Minneapolis, Minn., (1948).

E. H. Haase, B. & B. Supv., So. Pac. Co., Tucson, Ariz., (1943).
C. A. Hackett, Asst. B. & B. Supv., So. Pac. Co., El Paso, Tex., (1948).
S. H. Hailey, Engr. Fuel & W. S., N. C. & St. L. Ry., Nashville, Tenn., (1948).
P. D. Haines, B. & B. Supv., C. & O. Ry., Saginaw, Mich., (1943).
H. C. Halliday, B. & B. Master, Can. Nat'l Ry., Prince Rupert, B. C., Can. (1947)
A. Hamill, B. & B. Master, Esquimalt & Nanaimo Ry., Victoria, B. C., Can., (1948).
A. A. Hampton, Asst. Supv. B. & B., Mo. Pac. Lines, De Quincy, La., (1947).
J. S. Hancock, Br. Engr., D. T. & I. R. R., Dearborn, Mich., (1916).
G. W. Hand, Asst. to Pres., C. & N. W. Ry., Chicago (retired), (1909).
A. H. Hansbury, Gen. For. B. & B.-W. S., A. T. & S. F. Ry., Las Vegas, N. M., (1946).
J. A. Hanson, B. & B. Supv., N. Y. C. Sys., Cincinnati, Ohio. (1947).
C. R. Harding, Pres., The Pullman Co., Chicago (1924)
H. M. Harlow, Asst. Gen. Supv. B. & B., C. & O. Ry., Richmond, Va., (1939).
W. C. Harman, Supv. B. & B., So. Pac. Co., San Francisco, Calif., (1911).
M. J. Harp, Supv. B. & B., Mo. Pac. R. R., Poplar Bluff, Mo., (1938)
A. R. Harris, Engr. of Bridges, C. & N. W. Ry., Chicago, (1940).
L. M. Hartley, Mast. Carp., S. A. L. R. R., Tampa, Fla., (1948).
G. F. Hartman, Asst. Supv. B. & B., C. & O. Ry., Columbus, Ohio, (1947)
M. S. Harwood, Asst. B. & B. Supv, So. Pac. Co., San Francisco, Calif., (1948)
E. M. Hastings, Ch. Eng., R. F. & P. R. R., Richmond, Va., (1940).
J. J. Healy, Asst. B. & B., Supv., B. & M. R. R., Boston, Mass., (1947)
J. E. Heck, Supv. B. & B., C. & O. Ry., Ashland, Ky., (1938)
R. L. Hecker, B. & B. Supv., C. & O. R. R., Saginaw, Mich., (1947)
H. Heizenbuttel, (retired) B. & B. Supv., C. & N. W. Ry., 808 S. 3rd St., Norfolk, Nebr., (1917)
R. D. Hellweg, Asst. Div. Engr., G. M. & O. Ry., Bloomington, Ill., (1947)
B. Hemstad, Mast. Carp., Gr., Nor. Ry., Willmar, Minn., (1937).

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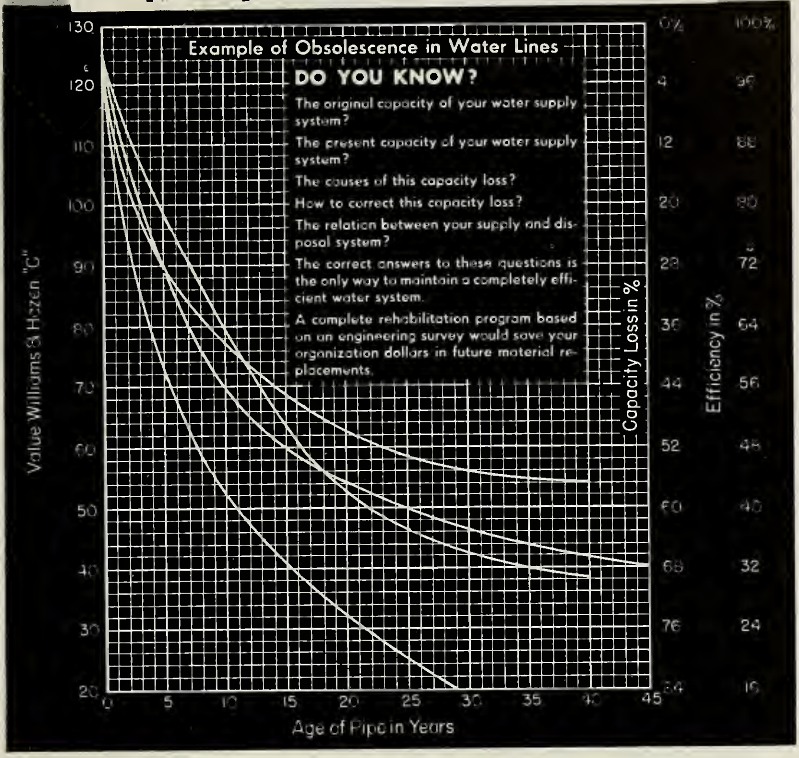

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H. R. Herrick, B. & B. Supv., So. Pac. Co., Tucson, Ariz. (1941)
G. C. Hill, Asst. Mast. Carp., P. R. R., Steubenville, Ohio, (1946).
R. F. Hill, Supv, B & B., C. I. & L. Ry., Crawfordsville, Ind., (1935).
A. B. Hillman, Engr. M. of W., C. & W. I.-Belt Ry., Chicago, (1942).
P. W. Hofstetter, Br. Insp., M. P. R. R., San Antonio, Tex., (1946).
V. V. Holmberg, Asst. Engr., C. & W. I. Ry., Chicago, (1942)
F. F. Hornig, Div. Engr., C. M. St. P. & P. R. R. Mason City, Iowa, (1947)
N. D. Howard, West. Ed., Railway Age, Chicago, (1926).
B. J. Howay, B. & B.-W.S., C & O. Ry., Grand Ledge, Mich., (1919)
A. C. Hoyt, B. & B. Engr., E. J. & E. R. R., Joliet, Ill., (1947)
M. J. Hubbard, Gen. Supv. B. & B., C. & O., Ry., Richmond, Va., (1948).
V. T. Huckaby, Steel Br. Insp., M. K. T. R. R. Co., Hillsboro, Tex., (1947)
W. A. Huckstep, Gen. Bldg. Supv., M. P. R. R., St. Louis, Mo., (1941).
W. H. Huffman, Div. Engr., C. & N. W. Ry., Chicago, (1941).
C. A. Hughes, Supt. B. & B., E. J. & E. Ry., Joliet, Ill., (1943).
F. G. Hull, B. & B. Supv., C. & O. Ry., St. Thomas, Ont., Can., (1947)
R. W. Humphreys, Div. Engr., Nor. Pac. Ry., Missoula, Mont., (1947)
G. R. Hunt, Architect, G. G. & S. F. Ry., Galveston, Tex., (1947)
H. A. Hunt, Resident Engr., T. & N. O. R. R., El Paso, Tex., (1946).
F. C. Huntsman, Div. Engr., Wab. R. R., St. Louis, Mo., (1922).
P. F. Huston, Mast. Carp., Colo. & So., Denver Colo., (1948).
F. W. Hutcheson, Asst. Supv. B. & B., C. & O. Ry., Newport News, Va., (1938).
W. A. Hutcheson, Supv. B. & B., C. & O. Ry., Clifton Forge, Va., (1939).
V. W. Hutchings, B. & B. Supv., S. P. Co., Bakersfield, Calif., (1941).

J. V. Inabinet, Gen. Br. Insp., S. A. L. R. R., Norfolk, Va., (1948).
J. A. Inmann, Gen. For. B. & B., St. L. S. F. Ry., Chaffee, Mo., (1947)
D. W. Isaacs, Mast. Carp., C. R. I. & P. Ry., Des Moines, Ia., (1947)
H. E. Jackman, Mast. Carp., B. & O. R. R., Chillicothe, Ohio, (1944).
T. E. Jackson, Gen. B. & B. Supv., So. Pac. Co., San Francisco, Calif., (1948).
W. R. Jacobson, Asst., Engr., M. St. P. & S. S. M. R. R., Stevens Point, Wis., (1948).
H. W. Jenkins, Asst. Div. Engr., N. Y. N. H. & H. R. R., Boston, Mass., (1940).
W. J. Jerrow, Asst. Mast. Carp., G. N. Ry., Whitefish, Mont., (1946).
A. C. Johnson, Supt. B. B., E. J. & E. Ry., Joliet, Ill., (1944)
B. O. Johnson, Asst. Engr., C. M. St. P. & P. R. R , Chicago. (1931).
D. H. Johnson, Supv. B. & B., C. St. P. M. & O. Ry., Altoona, Wisc., (1940).
H. G. Johnson, Asst. Engr., C. M. St. P. & P. R. R., Ottumwa, Ia., (1930).
M. Johnson, Prin. Asst. Engr., I. C. R. R., Chicago, (1915) (retired).
R. W. Johnson, Asst. Engr., C. M. St. P. & P. R. R., Chicago, (1922).
A. C. Jones, Supv. B. & B., So. Ry., Jasper, Ala., (1938).
E. B. Jones, Br. Insp., C. & O. Ry., Clifton Forge, Va., (1945).
J. A. Jorlett, Asst. Engr., Penna. R. R., New York, N. Y., (1946).

C. T. Kaier, Gen. Br. Insp., D. L. & W. R. R., Hoboken, N. J., (1937).
W. P. Karwich, Travelling B. & B. Insp., Erie R. R., Akron, Ohio, (1948).
R. D. Kelly, Asst. Supv. B. & B., C. & N. W. Ry., Chicago, (1942).
W. G. Kemmerer, Asst. Engr. B. & B., Penna. R. R., New York, (1931).
G. M. Ketchie, Jr., Asst. Engr. Bldgs., So. Ry., Charlotte, N. C., (1948).
L. P. Kimball, Eng. Bldg., B. & O. R. R., Baltimore, Md., (1921).
D. P. Kinzel, Supv. B. & B., N. Y. C. R. R., Delmar, N. Y., (1948).
T. R. Klingel, Asst. Prof., Engr. Dept., Univ. of Minn. Inst. of Tech., Minneapolis. Minn., (1943)
P. L. Koehler, Asst. Supt., C. & O. Ry., Peach Creek, W. Va., (1938).
M. E. Koenig, Asst. Supv., B. & B., C. & N. W. Ry., Boone, Ia., (1947).
W. B. Konkle, For. Carp., Reading Co., Milton, Pa., (1947)
A. S. Krefting, Prin. Asst. Eng., M. St. P. & S. S. M. Ry., Minneapolis, Minn. (1935).
H. H. Kruse, Ch. Carp., C. M St. P. & P. R. R., Mitchell, S. Dak. (1947).
P. F. Kuchera, Mast. Carp., C. B. & Q. R. R., Omaha, Nebr., (1947)
S. E. Kvenberg, Asst. Engr., C. M. St. P. & P. R. R., Chicago, (1932).

J. J. LaBat, B. & B. Supv., Mo. Pac. Ry., Wichita, Kans., (1937)
W. S. Lacher, Secy., Am. Ry. Engr. Assoc., Chicago, (1922).
C. W. Laird, Scale Supt., Mo. Pac. Lines, Houston, Tex., (1947)
L. R. Lamport, Engr. of Mtce., C. & N. W. Ry., Chicago, (1935).
W. Lampson, Supv., B. & B., Maine Cent. R. R., Portland, Me., (1930).
W. A. Langford, Asst. Supv. B. & B., Mo. Pac. R. R., Monroe, La., (1948).
J. S. Langston, Mast. Carp., C. R. I. & P. Ry., Little Rock, Ark., (1947)
K. Larson, Supv. B. & B., C. & N. W. Ry., Sioux City, Iowa, (1947).
V. L. Leck, G. F. B. & B. & W. C., St. L. S. F. Ry., Tulsa, Okla., (1948).
J. R. Leguenec, Supv., B. & B., St. L. S. W. Ry., Tyler, Tex., (1948).
F. J. A. Leinweber, B. & B. Mast., Can. Nat'l Rys., St. Thomas, Ont., Can., (1947).
J. A. Lewis, Supv. B. & B., N. Y. C. Sys., Buffalo, N. Y., (1948).

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F. W. Lichtenberger, Jr., Asst. Mast. Carp., Erie R. R., Paterson, N. J., (1945).
H. J. Lieser, Trk. Supv., Belt Ry. of Chicago, (1948).
J. H. Lindsay, Div. Eng., B. & O. R. R., Grafton, W. Va., (1946).
H. M. Link, Instrumentman, C. & N. W. Ry., Chadron, Nebr., (1940).
G. A. Linn, Div. Engr., C. & N. W. Ry., Chadron, Nebr., (1940).
C. A. Little, Asst. Supv. B. & B., B. & M. R. R., Concord, N. H., (1918).
H. C. Little, Supv. W. S. I. C. R. R., Vicksburg, Miss., (1948).
G. P. Lokotzke, Supv. B. & B., E. J. & E. Ry., Gary, Ind., (1947)
R. J. Lorber, Supv. B. & B., P. & P. U. Ry., Peoria, Ill., (1948).
H. T. Lord, B. & B. Master, Can. Pac. Ry., Kenora, Ont., (1940)
R. P. Luck, Dftsman, C. & N. W. Ry., Chicago, (1920).
C. V. Lund, Asst. Eng., C. M. St. P. & P. R. R., Chicago, (1947).
L. E. Lyon, Div. Engr., So. Pac. Co., El Paso, Tex., (1947)

H. C. Madson, Designer, C. & N. W. Ry., Chicago, (1940).
W. J. Mahoney, Supv. B. & B., L. & N. R. R., Louisville, Ky., (1946).
C. R. Malmberg, Asst. Supv. B. & B., C. & N. W. Ry., Milwaukee, Wisc., (1948).
B. F. Manley, Supv. B. & B., Pac. Elec. Ry. Co., Los Angeles, Cal., (1943).
D. A. Manning, Supv. B. & B., C. & N. W. Ry., Chicago, (1939).
W. K. Manning, Supv. Brs., Erie R. R., Port Jervis, N. Y., (1948).
L. S. Marriott, Gen. Bldg., Inspr., I. C. R. R., Chicago, (1947)
W. F. Martens, Gen. Frmn., B. & B., A. T. & S. F. Ry., San Bernardino, Calif., (1924).
G. E. Martin, Supt. W. S., I. C. R. R., Chicago, (1942).
J. U. Martin, Mast. Carp., S. A. L. R. R., Raleigh, N. C., (1946).
T. J. Martin, Gen. Mast. Carp., G. N. Ry., Seattle, Wash., (1940).
E. L. Mason, B. & B. Supv., Mo. Pac. Ry. Co., Kingsville, Tex., (1946).
W. G. Mateer, Pur. Agent, E. J. & E. Ry., Chicago, (1944).
R. C. Mathis, Br. Inspr., I. C. R. R., Memphis, Tenn., (1947)
A. N. Matthews, Gen. For. B. & B. and W. S. St. L. S. F. Ry., Fort Scott, Kans. (1947)
L. E. May, Gen. For. B. & B. & W. S., A. T. & S. F. Ry., Fresno, Calif., (1948).
L. Mayfield, Asst. Engr. Str., M. P. Lines, Houston, Tex., (1944).
J. W. N. Mays, Asst. Mast. Carp., Penn. R. R., Steubenville, Ohio, (1947)
J. McCaffery, Asst. Gen. Br. Insp., Sou. Pac. Co., San Francisco, Cal., (1922).
J. F. McCay, B. & B. Insp. N. Y. C. Sys. Chicago (1945).
C. A. McColgin, Mast. Carp., C. B. & Q. R. R., Hannibal, Mo., (1946).
A. A. McDermott, B. & B. Supv., So. Pac. Co., Dunsmuir, Calif., (1945).
J. W. McDonald, Gen. For. B. & B. W. S., St. L. S. F. Ry., Springfield, Mo., (1947).
F. O. McGrew, Ch. Carp., C. M. St. P. & P. R. R., Terre Haute, Ind., (1948).
E. R. McKee, Asst. Div. Engr., B. & O. R. R. Co., Washington, Ind., (1947)
P. F. McNally, B. & B. Supv., So. Pac. Co., Ogden, Utah, (1948).
W. R. Meeks, B. & B. Supv., M. P. R. R., Monroe, La., (1942).
B. W. Merrill, Supv. B. & B., N. Y. C. & St. L. R. R., Conneaut, Ohio, (1936).
P. B. Merwin, Asst. Eng., C. & N. W. Ry., Chicago, (1927).
B. R. Meyers, Asst. Ch. Engr., C. & N. W. Ry., Chicago, (1930).
H. E. Michael, Assoc. Ed. Railway Age and Ry. Engr. & Mtce. Chicago, (1947)
E. L. Miezanko, Asst. Gen. For. B. & B. & W. S., A. T. & S. F. Ry., San Bernardino, Calif., (1948).
C. E. Miller, Asst. Engr. Mtce., C. & N. W. Ry. Co., Chicago, (1916) (retired).
J. G. Miller, Mast. Carp., B. & O. R. R., Connelsville, Pa., (1948).
J. O. Miller, Mast. Carp., B. & O. Ry., Flora, Ill., (1945).
F. M. Misch, Gen. B. & B. Supv., So. Pac. Co., San Francisco, Cal., (1937).
D. N. Mitchell, Asst. Supv. B. & B., C. & O. R. R., Newport News, Va., (1948).
E. W. Moore, Mast. Carp., C. B. & Q. R. R., Centerville, Iowa, (1942).
I. A. Moore, Asst. Chief Engr., C. & E. I. R. R., Danville, Ill., (1937).
J. D. Moore, Jr., Asst. Mast. Carp., Penn. R. R. Philadelphia, Pa., (1947)
J. H. Morgan, Engr. M. of W., F. E. C. Ry., St. Augustine, Fla., (1948).
L. R. Morgan, Fire Prev. Eng., N. Y. C. R. R., Detroit, Mich., (1937).
E. N. Morin, B. & B. Mast., C. P. R., Farnham, Que., (1946).
W. O. Morris, Supv. W. S., I. C. R. R., Waterloo, Ia., (1947)
R. H. Morrison, Prin. Asst. Engr., B. & A. Ry., Houlton, Me., (1941).
C. L. Moser, Supv. B. & B., So. Ry., Asheville N. C., (1948).
C. H. Mottier, V.-P. & Ch. Eng., I. C. Sys., Chicago, (1942).
C. A. Murtaugh, Mast. Carp., Erie R. R., Marion, Ohio (1939)

G. W. Neal, Supt., Chattahoochee Valley Ry., West Point, Ga., (1948).
E. I. Nelson, W. S. For., Mo. Pac. Ry., Nevada, Mo., (1948)
R. A. Nelson, Constr. Engr., C. G. W. R. R., Chicago, Ill., (1948).
W. O. Nelson, Reg. Br. Insp., B. & O. R. R., Baltimore, Md., (1947)
J. E. Nielsen, Asst. Engr. of Bldgs., C. B. & Q. R. R., Chicago, (1947)
H. Norris, Asst. Supv. B. & B., F. E. C. Ry., Miami, Fla., (1948).
M. S. Norris, Asst. Eng., B. & O. R. R., Pittsburgh, Pa., (1946).

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C. O. Nuckolls, Ch. Engr. S. S. Ry. Co., Sand Springs, Okla., (1944).
W. Nuetzel, Asst. Engr. Brdgs., B. & O. C. T. R. R., Chicago, (1945).

W. C. Oest, Prin. Asst. Engr., Ft. .W & D. C. Ry. (Burlington), Ft. Worth, Tex. (1947)
G. Olson, Asst. Supt. B. & B., C. & N. W. Ry., Sioux City, Ia., (1944).
V. E. Olson, B. & B. Supv., M. St. P. & S. S. M., Stevens Point, Wis., (1948).
B. J. Ornburn, Engr. & Supt., C. M. St. P. & P. R. R., Chicago, (1948).
T. D. Osbourne, Asst. B. & B. Supv., So. Pac. Co., Alhambra, Calif., (1943).
C. N. Overdahl, Asst. B. & B. Supv., N. P. Ry., Tacoma, Wash., (1948).
C. Owens, Supv. B. & B., N. Y. O. & W. R. R., Middleton, N. Y., (1948).
A. Parisien, B. & B. Mast., Can. Pac. Ry., Schreiber, Ont., Can., (1927).
E. Park, Jr., Draftsman, Mo. Pac. Lines, Houston, Tex., (1948)
W. V. Parker, Gen. For. B. & B., St. L. S. W. Ry., Retired, Memphis, Tenn., (1911).
E. L. Parrish, B. & B. Supv., I. C. R. R., Vicksburg, Miss., (1947)
H. E. Passel, Div. Engr., B. & O. R. R., Indianapolis, Ind, (1948).
E. Patenaude, B. & B. Mast., C. P. R., Sudbury, Ont., Can., (1930).
R. E. Paulson, Ch. Dftsman. C. M. St. P. & P. R. R., Chicago, (1945).
J. R. Penhallegon, Asst. B. & B. Supv., C. & N. W. Ry., Chicago, (1940).
L. R. Pennington, B. & B. Supv., C. & N. W. R. R., Chadron, Nebr., (1938).
M. E. Peppin, Asst. Engr., A. T. & S. F. Ry., Glendale, Calif., (1947)
G. H. Perry, Mast. Carp., Penna. R. R., New Castle, Pa., (1948).
N. E. Peterson, Engr. M. of W., C. & I. M. Ry., Springfield, Ill., (1938)
W. F. Pettys, Div. Engr., Erie R. R., Youngstown, Ohio, (1948).
L. E. Peyser, Architect, So. Pac. Co., San Francisco, Calif., (1937)
A. Pfeiffer, Asst. B. & B. Supv., So. Pac. Co., Stockton, Calif., (1939).
C. E. Phelps, B. & B. Supv., Georgia R. R., Camak, Ga., (1948).
B. C. Phillips, Mast. Carp., C. B. & Q. R. R., Alliance, Nebr., (1947)
W. J. Phillips, Asst. Gen. Br. Insp., So. Pac. Co., Berkeley, Calif., (1925).
T. W. Pinard, B. & B. Engr., Penn. R. R., New York, (1920).
N. F. Podas, Ch. Engr., Minn. Trans. Co. & St. Paul Un. Depot Co., St. Paul, Minn., (1937).
H. M. Potts, Mast. Carp., B. & O. R. R., Wheeling, W. Va., (1946).
W. G. Powrie, Engr. M. of W., C. M. St. P. & P. R. R., Chicago, (1939).
R. G. Preston, Asst. Engr., Penn. R. R., Chicago, (1947)
G. H. Priest, Gen. For. B. & B., Can. Nat. Ry., Foxboro, Ont., Canada, (1948).
C. R. Pritchard, Asst. Arch., So. R. R., Charlotte, N. C., (1948).
W. H. Pryor, Gen. For. B. & B. and W. S., St. L.-S. F. Ry., Memphis, Tenn., (1946)

W. H. Rainey, Asst. B. & B. Supv., T. & N. O. R. R., San Antonio, Tex., (1947).
W. F. Raley, Mast. Carp., B. & O. R. R., Callery, Pa., (1949).
L. F. Rapier, Supv. B. & B., G. M. & O. R. R., Bloomington, Ill., (1946).
G. W. Rear, Jr., Asst. Gen. Fire Insp., Sou. Pac. Co., San Francisco, Calif., (1939).
A. N. Reece, Asst. to Pres., K. C. S. Ry., Kansas City, Mo., (1922).
A. D. Reed, Mast. Carp., C. B. & Q. R. R., McCook, Nebr., (1945).
F. A. Reed, Supv. B. & B., I. C. R. R., Clinton, Ill., (1947)
A. G. Reese, Dist. Maint. Engr., C. B. & Q. R. R., Galesburg, Ill., (1947)
O. C. Rhoades, Asst. Supv. B. & B., C. & N. W. Ry., Fond du Lac, Wisc., (1947).
C. A. J. Richards, Mast. Carp., Penna. R. R., Grand Rapids, Mich., (1924).
H. B. Richardson, B. & B. Supv., B. & M. R. R., P. O. Box 383, Somersworth, N. H., (1948).
D. T. Rintoul, Gen. Br. Insp., So. Pac. Co., San Francisco, Calif., (1910).
C. A. Roberts, Ch. Draftsman, Erie R. R., Cleveland, Ohio, (1948).
B. L. Robinson, Conc. Asst., A. A. R., 59 E. Van Buren St., Chicago, (1948).
G. E. Robinson, Engr. of Structs., N. Y. C. System, Chicago, (1948).
N. R. Robinson, B. & B. Supv., So. Pac. Co., Sacramento. Calif., (1934).
L. A. Rode, Gen. Br. Insp., Erie R. R., Newark, N. J., (1948).
T. S. Ronan, Supv. B. & B., C. & N. W. Ry., Pierre, S. Dak., (1947)
H. W. Routenberg, Mast. Carp., B. & O. R. R., Baltimore, Md., (1946).
R. T. Rumbold, B. & B. Supv., So. Ry., Greensboro, N. C., (1947)
C. E. Russell, Supv. W. S., Ill. Cent. R. R., Chicago, (1944).
G. M. Ryan, B. & B. Supv., N. Y., N. H. & H. R. R., Boston, Mass., (1947)

J. R. Safley, Asst. B. & B. Supv., So. Pac. Co., Dunsmuir, Calif., (1945)
J. M. Salmon, Jr., Asst. Br. Insp., L. & N. R. R., Louisville, Ky., (1938).
T. D. Saunders, Ch. Engr., Ontario Northland Ry., North Bay, Ont., Can., (1930).
P. J. Scherer, Supv. B. & B., So. Pac. Co., El Paso, Tex., (1936).
F. F. Schilt, Asst. Div. Engr., B. & O. R. R., Grafton, W. Va., (1946).
E. R. Schlaf, Asst. Supt. W. S., I. C. R. R., Chicago, (1947).
C. E. Schofield, Asst. Mast. Carp., S. A. L. R. R., Savannah, Ga., (1948).
D. E. Schreiber, Fore. W. S., M. P. R. R., Jefferson City, Mo, (1948).

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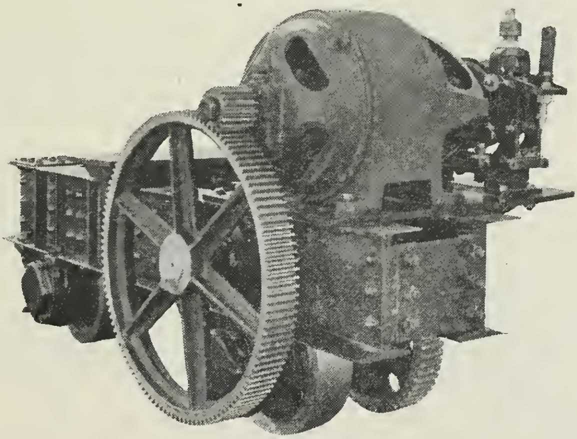

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L. L. Seley, Mast. Carp., C. B. & Q. R. R., Hannibal, Mo., (1947).
L. A. Shaefer, Fore. W. S., M. P. R. R., Osawatomie, Kan., (1948).
J. F. Shanklin, Asst. Gen. Br. Insp., C. & N. W. Ry., Chicago, (1947).
C. J. Shapland, Asst. Engr., B. & B., C. V. Ry., (Can. Nat'l. Rys.), St. Albans, Vt., (1945)
S. H. Shepley, Supv. Track. E. J. & E. Ry., Joliet, Ill., (1945).
F. Shobert, Sys. Steel Const. Frm., So. Pac. Co., Oakland, Cal., (1918).
J. R. Showalter, Br. Engr., M. P. R. R., St. Louis, Mo., (1942).
F. A. Siegfried, For. Carp. B. & B., Reading Co., Reading, Pa., (1947)
E. W. Simpson, Steel Br. Insp., A. T. & S. F. Ry., Los Angeles, Calif., (1948).
P. X. Simpson, Supv B. & B., Nor. Pac. Ry., Tacoma, Wash., (1947)
C. C. Sims, Supv. B. & B., C. & O Ry.,Hinton, W. Va., (1947)
E. W. Singer, Supv. B. & B., N. Y. C. & St. L. R. R., Fort Wayne, Ind., (1923).
A. A. Sirel, Br. Asst., A. A. R., Chicago, (1940).
G. L. Sitton, Asst. Ch. Engr., So. Ry. Sys., Washington, D. C., (1920).
H. E. Skinner, Supv. S. & W. Equip., E. J. & E. Ry., Joliet, Ill., (1944).
G. P. Slagle, Ch. Carp., C. M. St. P. & P. R. R., Milwaukee, Wis., (1948).
F. M. Sloane, Div. Eng., C. M. St. P. & P. R. R. Co., Milwaukee, Wis., (1927).
B. Smart, Trk. Supv., D. T. & I. R. R., Dearborn, Mich., (1945).
C. A. Smith, Supv. B. & B., C. R. & I.-I. H. B. R. R., Hammond, Ind., (1946)
C. E. Smith, Vice-Pres., N. Y. N. H. & H. R. R., New Haven, Conn., (1911).
F. W. Smith, Railway Age, Chicago, (1944)
H. E. Smith, Engr. M. of W., G. H. & H., Galveston, Tex., (1941).
J. Smith, Asst. B. & B. Supv., So. Pac. Co., Sacramento, Cal., (1943).
L. C. Smith, Div. Engr., C. & N. W. Ry., Madison, Wis., (1942)
L. L. Smith, Asst. B. & B. Supv., So. Pa. Co., Dunsmuir, Calif., (1948).
R. H. Snow, Gen. For., Maine Cent. R. R., Waterville, Maine, (1947)
E. F. Snyder, Div. Engr., I. C. R. R., Jackson, Tenn., (1948).
R. H. Snyder, Trainmaster, So. Ry., Asheville, N. C., (1946).
G. R. Sproles, Div. Engr., L. & N. R. R., Mobile, Ala., (1948).
F. R. Spofford, Asst. Div. Engr., B. & M. R. R., Dover, N. H. (1940).
G. L. Staley, Br. Engr., M.-K.-T. R. R., St. Louis, Mo., (1946).
W. B. Starnes, Br. Inspr., Mo. Pac. Lines, Kingsville, Tex., (1947)
G. T. Steidel, Br. Eng., L. & N. E. R. R., Bethlehem, Pa., (1946).
B. M. Stephens, Asst. to Ch. Engr., T. & N. O. R. R., Houston, Tex., (1946).
O. W. Stephens, Asst. Eng. Str., D. & H. R. R., Albany, N. Y., (1941).
I. F. Stern, Con. Engr., Chicago, (1943).
F. J. Stewart, Port Engr., Port Everglades Belt Line Ry., Port Everglades (Ft. Lauderdale), Fla., (1944).
W. Stoneman, Jr., Asst. B. & B. Supv., So. Pac. Co., El Cerrito, Calif., (1948).
J. A. Strouss, Asst. B. & B. Supv., Sou. Pac. Co., Sacramento, Calif., (1934).
W. J. Strout, Ch. Engr., B. & A. R. R., Houlton, Me., (1932).
J. W. Stutzman, For. Carp., Reading Co., Reading, Pa., (1947)
J. Sumner, W. S. Fore., St. L. S. F. Ry., Springfield, Mo., (1948).
W. A. Sweet, Gen. Frm. B. & B., A. T. & S. F. Ry., Newton, Kans., (1928).

C. R. Taggart, Supv. B. & B., N. Y. C. Sys., Indianapolis, Ind., 1935).
C. L. Tanner, Gen. For. B. & B. & W. S., P. & S. F., Slaton, Tex., (1948).
E. E. Tanner, Gen. Supv., B. & B., N. Y. C. Sys., Albany, N. Y., (1938).
E. R. Tattershall, Supt. Mtce. Eqpt., N. Y. C., Sys., New York, N. Y., (1913).
R. S. Templin, For. Carp., Reading Co., Pottsville, Pa., (1947)
L. J. Tetreault, B. & B. For., N. Y. N. H. & H. R. R., Worcester, Mass., (1936).
P. V. Thelander, Asst. Engr. of Mtce., C. & N. W. Ry., Chicago, (1939).
F. W. Thompson, Ch. Engr., C. R. I. & P. Ry., Chicago, (1946).
S. R. Thurman, Supv. B. & B., Mo. Pac. R. R., Nevada, Mo., (1943).
A. C. Tinsley, Supv. B. & B , N. & W. Ry., Crewe, Va., (1945).
D. C. Todd, Mast. Carp., Penna. R. R., Pittsburgh, Pa., (1942).
O. G. Todd, Asst. Div. Engr., B. & O. R. R., Garrett, Ind., (1946).
E. B. Tourtelotte, Supv. B. & B., B. & M. R. R., Greenfield, Mass., (1947).
J. F. Towmey, Mast. Carp., Penna. R. R., Chicago, (1948).
D. E. Tracy, Asst. B. & B. Supv., So. Pac. Co., Bakersfield, Calif., (1946).
J. D. Trulove, Asst. B. & B. Supv., So. Pac. Co., Ogden, Utah, (1945).
N. R. Tucker, Asst. Div. Engr., T. & N. O. R. R., (So. Pac. Lines) Lafayette, La., (1939)
H. C. Tunison, Asst. Engr. M. of W., L. & N. E. R. R., Bethlehem, Pa., (1946).
A. E. Tupper, B. & B. For., So. Pac. Co., Stockton, Calif., (1942).
W. L. Turner, Jr., Assoc. Ed. Railway Age., New York, N. Y., (1946).

E. C. Vandenburgh, Chief Engr., C. & N. W. Ry., Chicago, (1925).
J. L. Varker, Div. Engr., D. & H. R. R., Carbondale, Pa., (1936)
H. L. Veith, B. & B. Supv., So. Ry.. Birmingham, Ala., (1942).
R. E. Ventress, Mast. Carp., G. M. & O. Ry., Springfield, Ill., (1946).
T. M. Van Sprecken, Asst. to Ch. Engr., So. Ry., Washington, D. C., (1938).
J. S. Vreeland, Sales Repr., Ry. Engr. & Mtce., New York, (1940).

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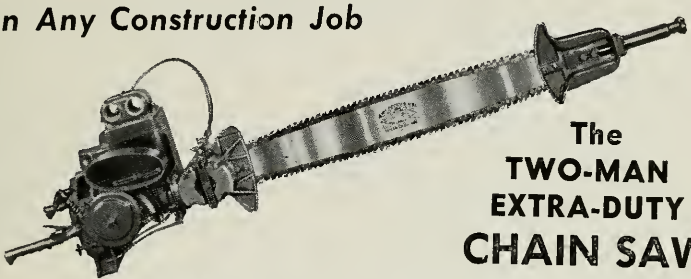

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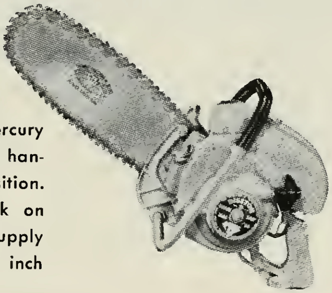

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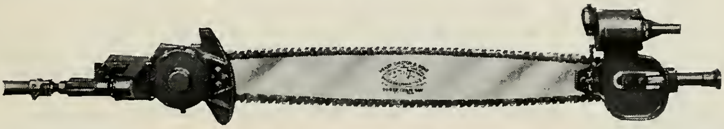

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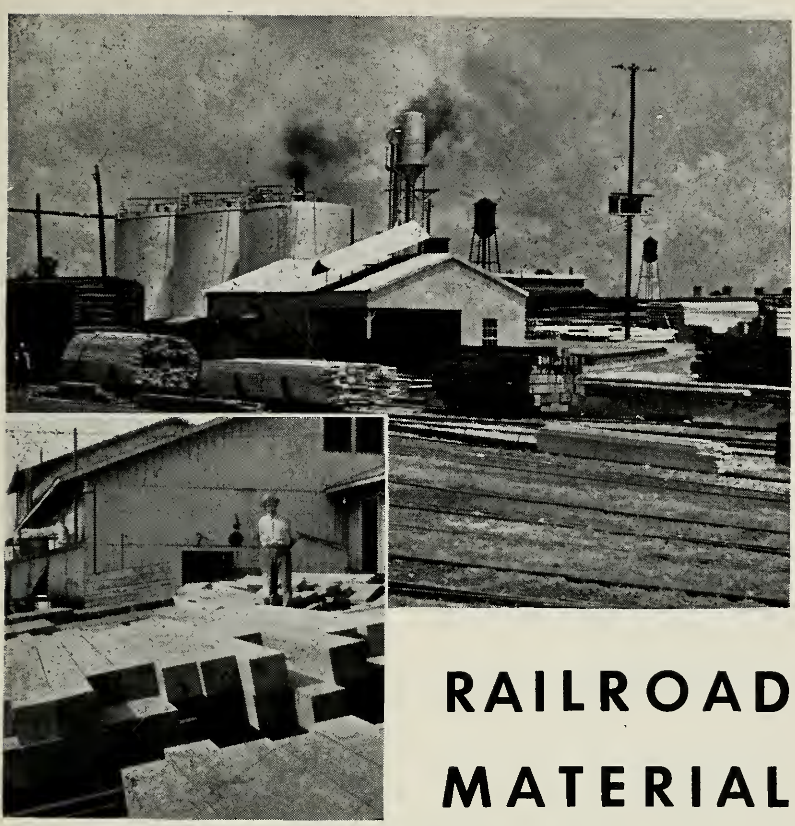
G. P. Walker, Supv. B. & B., Mo. Pac. Ry., Monroe, La., (1929).
H. D. Walker, Prin. Asst. Engr., I. C. C. R. R., Chicago, (1947)
E. G. Wall, Div. Engr., G. M. & O. Ry., Bloomington, Ill., (1942)
R. Wall, Supv., B. & B., So. Ry., Selma, Ala., (1948).
C. E. Wallace, Gen. For. B. & B. & W. S., S. L. S. F. Ry., Ft. Smith, Ark., (1948).
J. A. Walsh, Mast. Carp., Reading R. R., Philadelphia, Pa., (1948).
J. Walsh, Mast. Carp., C. B. & Q. R. R., Beardstown, Ill., (1942).
W. B. Warfield, Mast Carp., Penn. R. R., Buffalo, N. Y., (1947)
J. F. Warrenfells, Mast. Carp., S. A. L. R. R., Savannah, Ga., (1946).
W. M. Warso, Engr., Monongahela Connecting R. R., Pittsburgh, Pa., (1948)
L. W. Watson, Dist. Br. Insp., B. & O. R. R. Co., (Mt. Lebanon), Pittsburgh, Pa., (1944).
E. H. Weaver, B. & B. Insp., N.Y.C. Sys.,Syracuse, N. Y., (1945)
G. R. Webber, Ch. Carp., C. M. S. P. & P. R. R., Spokane, Wash., (1948).
T. J. Webster, Mast. Carp., C. R. I. & P. Ry., Kansas City, Mo., (1941).
D. E. Weidner, For. Carp., Reading Co., Harrisburg, Pa., (1947)
J. W. Welch, Supv. B. & B., F. E. C. Lines, St. Augustine, Fla. (1943).
W. M. Wells, Asst. Div. Eng., B. & O. R. R., Washington, Ind., (1946).
O. C. Wentling, B. & B. Inspr., N. Y. C. Lines, Chicago, (1947)
J. R. Wenzel, Asst. Supv. B. & B., C. & N. W. Ry., Boone, Iowa, (1946).
G. H. West, Term. For., West. Maryland Ry., Waynesboro, Pa., (1947)
R. A. Westergren, Mast. Carp., Penn. R. R., Sunbury, Pa.,)1947)
J. W. Westwood, Div. Engr., N. Y. C. Lines, Detroit., (1941)
J. C. White, Div. Engr., N. Y. C. Lines, Indianapolis, Ind., (1947)
L. H. White, B. & B. Supv., Ill. Cent. R. R., Carbondale, Ill., (1946).
S. White, Senior-Asst. B. & B. Supv., So. Pac. Co., El Paso, Tex., (1942)
B. M. Whitehouse, Ch. Fire Insp., C. & N. W. Ry., Chicago, (1927).
R. V. Wickman, Supv. B. & B., B. & A. Ry., Pittsfield, Mass., (1948)
A. Wiitala, Gen. For., B. & B., L. S. & I. Ry., Marquette, Mich., (1941).
Wm. Wilbur, Div. Engr., C. & N. W. Ry., Green Bay, Wis., (1947).
N. H. Williams, B. & B. Supv., D. & H. R. R., Oneonta, N. Y., (1947)
W. T. Williams, B. & B. Supv., T. & N. O. R. R., Ennis, Tex., (1947)
R. P. Wilson, Asst. Supv., B. & B., C. & O. Ry., Hinton, W. Va., (1948).
L. C. Winkelhaus, Arch. Eng., C. & N. W. Ry., Chicago, (1934).
J. J. Winn, Supv. B. & B., B. & M. R. R., Boston, Mass., (1946).
F. J. Wirges, Mast. Carp., C. R. I. & P. Ry., El Reno, Okla., (1948).
H. A. Wistrich, Asst. Ch. Engr., L. V. R. R., New York, (1938).
J. P. Witherspoon, Asst. Mast. Carp., S. A. L. R. R., Atlanta, Ga., (1948).
H. O. Wray, Engr. M. W. & S., Tex. City Trml. Ry., Texas City, Tex., (1939).
H. Wrights, Supv. B. & B., Mo. Pac. Ry., Little Rock, Ark., (1929)

J. E. Yewell, Engr. B. & B., B. & L. E. R. R., Greenville, Pa., (1941).
O. S. Youngblood, Asst. Supv., B. & B., C. of Ga. Ry. Co., Savannah, Ga., (1946).

LIFE MEMBERS

P. Aagaard, Supv. Bldg., I. C. R. R., 6826 S. Dante, Chicago, (1906)
N. C. Ailes, Asst. Val. Engr., D. & H. R. R., Berlin Ctr., Mahoaning Center, Ohio, (1915).
R. D. Anderson, Div. Engr., C. & N. W. Ry., Huron, S. D., (1923)
W. J. Azer, Supv. B. & B., C. & N. W. Ry., W. Chicago, Ill., (1920)
F. Brie, Steel Br. For., P. M. Ry., 2418 Casper, Detroit, Mich. (1922).
W. Buckingham, Br. For., M. C. R. R., 907 Chittock Ave., Jackson, Mich., (1928)
H. M. Church, Gen. Supv., B. & B., C. & O. Ry., 509 N. Boulevard, Richmond, Va., (1939).
J. B. Clancy, Supv. Bldgs. D. & H. R. R., 924 Melrose Ave., St. Petersburg, Fla., (1930).
W. A. Clark, Off. Engr., D. M. & I. R. R., 2718 E. 5th St., Duluth, Minn., (1908)
J. Conley, c/o Asst. Gen. Fire Insp., So. Pac. Co., San Francisco, Calif. (1937)
S. T. Corey, Off. Engr. & Engr. of Bridges, C. R. I. & P. R. R., 7250 Harvard Ave., Chicago, (1921).
G. M. Cota, Chf. Clk. Eng. Dept., C. Vt. Ry., St. Albans, Vt., (1913)
G. S. Crites, Div. Engr., B. & O. R. R., 4409 Underwood Rd., Baltimore, Md., (1912)
E. G. Day, Ch. Engr., L. S. & I. R. R., 450 E. Ridge St., Marquette, Mich., (1923).
H. H. Decker, Res. Engr., C. & N. W. Ry., 2915 Ingersoll Ave., Des Moines, Ia., (1908).
E. Drury, Gen. For. B. & B., A. T. & S. F. Ry., Newton, Kans. (1919)
W. R. Edwards. Asst. Engr. Brgs., B. & O. R. R., 2133 Bolton St., Baltimore, Md., (1912)
H. H. Eggleston, Supv. B. & B., C. G. W. Ry., 1816 E. 55th St., Kansas City, Mo., (1901).



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C. Ettinger, Gen. Ptr. For., I. C. R. R., 7046 Cornell Ave., Chicago, (1911)
M. J. Flynn, Supv. B. & B., C. & N. W. Ry., 2445 Coyle Ave., Chicago, (1905)
B. F. Gehr, Mast. Carp., Penn. R. R., 400 S. 14th St., Richmond, Ind., (1908).
I. Gentis, For. B. & B., So. Pac. Co., 2004 West St., Oakland, Calif., (1912)
H. A. Gerst, Asst. Engr. G. N. Ry., 748 Aldine St., St. Paul, Minn., (1917)
J. E. Gillette, Carp. For., C. M. St. P. & P. Ry., Mazomanie, Wis., (1923)
O. C. Gongoll, Supv. B. & B., M. St. P. & S. S. M. Ry., 2630½ Dupont Ave., Minneapolis, Minn., (1917).
B. A. Guill, Supv. B. & B. Georgia R. R., Camok, Ga., (1901)
E. Gunderson, Supv. B. & B., C. St. P. M. & O. Ry., Altoona, Wis., (1927).
T. L. D. Hadwen, Engr. Masonry Constr., C. M. St. P. & P. Ry., 1140 N. La Salle, Chicago, (1907)
J. R. Hartwell, Supv. B. & B., C. & N. W. Ry., Pierre, S. D., (1918)
C. W. Heuss, Supv. B. & B., C. C. C. & St. L. Ry., 1840 Lexington, Indianapolis, Ind., (1919)
F. W. Hillman, Asst. Engr., M. of W., C. & N. W. Ry., Evanston, (1917).
J. P. Hofacker, Supv. B. & B., L. V. Ry., 54 N. Fulton St., Auburn, N. Y., (1907)
H. A. Horning, Asst. Supt. Bldgs., M. C. R. R., 1106 Francis St., Jackson, Mich., (1902)
J. S. Huntoon, Asst. Br. Engr., Mich. Cent. R. R., 250 Grove Ave., Highland Park, Mich., (1915).
B. L. Johnson, Gen. Mast. Carp., G. N. Ry., 1007 W. 18th St., Spokane, Wash., (1919)
S. J. Johnson, Supv., B. & B., M. & St. L. R. R., 408 N. Center St., Marshalltown, Iowa, (1922)
E. J. Knetzger, For. B. & B., So. Pac. Co., 3140 E. 27th St., Oakland, Calif., (1926)
H. L. Koch, Supv. B. & B., N. Y. C. & St. L. Ry., Conneaut, Ohio, (1922)
W. J. Lacey, B. & B. Sup., Mo. Pac. Ry., 4370 Swan St., St. Louis, Mo., (1911)
C. A. Landstrom, Supv., B. & B., C. B. & Q. R. R., 1311 So. 3rd St., Burlington, Iowa, (1928).
H. M. Large, Mast. Carp., Penn. R. R., 511 Geddings Ave., Grand Rapids, Mich., (1908)
H. C. Larsen, Str. Iron Foreman, C. St. P. M. & O. Ry., 1084 Sims Ave., St. Paul, Minn., (1928).
S. Lincoln, Gen. For. B. & B., G. C. & S. F. Ry., 1903 Harrison Ave., Beaumont, Tex., (1927)
C. G. Lindstrom, For. B. & B., C. M. St. P. & P. Ry., Rockwell City, Iowa, (1924)
C. R. Lyman For. B. & B., Central Vermont Ry., Waterbury, Vt., (1913)

F. H. Masters, Ch. Engr., E. J. & E. R. R., 907 Glenwood Ave., Joliet, Ill., (1920).
E. M. McCabe, Supv. B. & B., B. & A. R. R., Pentoosuc Lake, Pittsfield, Mass., (1915)
A. L. McCloy, Supv. B. & B., P. M. Ry., 1714 Fitzhugh, Saginaw, Mich., (1913)
G. G. McCue, Supv. B. & B., G. T. R. R., 369 Main St., Ottawa, E. Ont., (1913)
H. A. McElhinney, B. & B. Mast., C. N. Ry., 9 Beech St., Halifax, N. S., (1923)
A. G. McKay, Supv. B. & N. Y. N. H. & H. R. R., 11 Pine Island Road, Jupiter Pt. Groton, Conn., (1915).
T. D. McMahon, Architect, G. N. Ry.. 223 Lake Ave., White Bear Lake, Minn., (1918)
H. C. McNaughton, Supv., B. & B., B. & M. R. R., Greenfield, Mass., (1915).
E. L. Mead, Div. Engr., C. & N. W. Ry., 536 N. E. 69th St., Miami, Fla., (1923)
J. Mellgren, For. W. S., C. & N. W. Ry., 523 N. Caldwell Ave., Eagle Grove, Iowa (1913)

E. C. Neville, Retired Supv., B. & B., G. T. W. Toronto, Ont., Can., (1920).
A. B. Nies, Architect, Mich. Cent. R. R. (NYC), 408 Third St., Jackson, Mich., (1915)

W. J. O'Brien, Dist. Carp., C. M. St. P. & P. Ry., Necedah, Wisc., (1919).
J. A. Owen, For. B. & B., D. & M. Ry., E. Towas, Mich., (1915)

P. Paulson, Supv. B. & B., C. & N. W. Ry., 547 Simmons Ave., S. E., Huron, S. D., (1923)
C. Piccone, Engr. of Brs., Nat. Rys. of Mex., Mexico City, Mex., (1923).

W. L. Ratliff, Supv., B. & B., I. C. R. R., McComb, Miss., (1913)
D. L. Rehmert, Mast. Carp. Penn. R. R., 104 W. 3rd Ave., Columbus, Ohio, (1918).
H. T. Rights, Asst. Brg. Eng., L. V. R. R., 1015 Raymond Ave., Bethlehem, Pa., (1927).
O. F. Rowland, Asst. Engr., D. & H. R. R., c/o Industrial Farm, Canaan, N. Y., (1923)

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Problem. An overhead water line used to fill locomotive boilers in a midwest roundhouse was badly clogged with scale. It was impossible to clean the line mechanically because of valves, elbows and varying pipe sizes in the 1,300 foot length. Replacement cost was approximately $3,000.

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Results. Railroad officials described the line as 100% clean. The length of time required to fill a locomotive with water from this line was greatly shortened.

Dowell Chemical Scale Removal Service has also proven effective for cleaning locomotive and stationary boilers, underground and surface lines, and for increasing production from water wells.

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F B. Scheetz, Asst. Engr., Mo. Pac., Ry., 3930 Connecticut Ave. Washington, D. C., (1905)
I. L. Simmons, Br. Engr., C. R. I. & P. Ry., Winter Park, Fla., (1913)
C. U. Smith, Consulting Engr., P. O. Box 953, Lindsay, Calif., (1915).
H. B. Stuart, Str. Engh., G. T. Ry., 4205 Dorchester St., Westmount, Que., Can., (1913)
D. Speaker, Mast. Carp., Penna. R. R., 813 N. 4th St., Steubenville, Ohio, (1928).
T. H. Strate. Div. Engr., C. M. St. P. & P. R. R., 6753 N. Sioux Ave., Chicago, (1918).

J. L. Talbott, Gen. For. B. & B., A. T. & S. F. Ry., Pueblo, Colo., 228 Park St., Morgantown, W. Va., (1905)
F. A. Taylor, Mast. Carp., B. & O. R. R., 2970 Mattern Ave., Pittsburgh, Pa., (1909)

W. H. Vance, Asst. Engr. M. of W., M. P. R. R., 6347 Alamo Ave., Clayton, Mo., (1910).
E. J. Vincent, For. B. & B., So. Pac. Co., 1740 So. Hoover, Los Angeles, Calif., (1911)
H. VonSchrenk, Const. Tbr. Engr., D. L. & W. Ry., 509 Chouteau Bldg., St. Louis, Mo., (1916).

W. H. Walden, Rdm., Sou. Ry., 1012 Porter St., Richmond, Va., (1920)
L. A. Warren, Supv., B. B., So. Pac. Co., Del Paso Heights, Calif., (1929).
W. Watson, Supv., B. & B., E. J. & E. Ry., Joliet, Ill., (1930)
F. W. White, Supv. B. & B., L. V. R. R., 409 S. Wilbur Ave., Sayre, Pa., (1915)
W. E. White, Gen. For., A. T. & S. F. Ry., Chanute, Kans., (1920).
J. J. Wishart, Supv., B. & B., N. Y. N. H. & H., 21 Elmlawn Rd., Braintree, Mass., (1915)
C. F. Womeldorf, Div. Engr., C. & N. W. Ry., 111 No. 12th St., Norfolk, Nebr., (1917)
C. W. Wright, Mast. Carp., L. I. R. R., 67 Nassau Parkway, Oceanside, N. Y., (1908)
H. Wuerth, Div. Engr., C. M. St. P. & P. R. R., Savanna, Ill., (1919)

R. C. Young, Ch. Engr. L. S. & I. R. R., 719 Pine St., Marquette, Mich., (1907).

E. C. Zinmeister, Mast. Carp., B. & O. R. R., 312 Tenth St., N., St. Petersburg, Fla., (1905)

CHARTER MEMBER

G. W. Gooch, (retired), 1325 W. 9th St., Des Moines, Ia., (1891)

HONORARY MEMBERS

Ralph Budd, Chf. Exec. Off., C. B. & Q. R. R., Chicago, (1927)
Charles H. Buford, Pres., C. M. St. P. & P. Ry., Chicago, (1946).
C. E. Johnston, Chairman, West. Assoc. Ry. Ex., La Jolla, Calif., (1911).

ASSOCIATE MEMBERS

L. Adams, Oxweld Railroad Service Co., 230 N. Michigan Ave., Chicago, (1943).
W. P. Arnold, Asst. to V.-P. (Wood Preservg. Div.), Koppers Co., Inc., Pittsburgh, Pa., (1946).
C. K. Avery, 15-559 Woodworth Ave., Detroit, Mich., (1946).

G. H. Bailey, Mgr. R. R. Div., Morrison-Knudsen Co., 411 W. 5th St., LosAngeles, Calif., (1946)
D. L. Baker, V.-P., Baker & Hickey Co., 85 E. Gay St., Columbus, Ohio, (1946).
A. E. Bardwell, West. Div. Mgr., Fabreeka Products Co., 225 N. Wabash Ave., Chicago, (1946).
R. H. Bescher, Mgr. of Tech. Dept., Wood Pres. Div., Koppers Co., Inc., Koppers Bldg., Pittsburgh, Pa., (1948).
G. R. Betts, Mgr. R. R. Sales, Armco Drainage & Metal Prod., Inc., 310 S. Michigan Ave., Chicago, (1946).
D. B. Bishop, Sales Eng., Dearborn Chemical Co., 1512 Farmers Bank Bldg., Pittsburgh, Pa., (1946).

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J. D. **Bolton,** J. D. Bolton & Co., 20 N. Wacker Dr., Chicago, (1946).
Chas. H. **Borcherding,** Sr., Field Engr., The Master Builders Co., 13 W. 25th St., Baltimore 18, Md., (1947).
C. R. **Boulton,** R. R. Contractor, 15 E. Town St., Columbus, Ohio, (1946).
J. P. **Burkey,** Con. Engr., Union Metal Mfg. Co., 2421 Plymouth Ave., Columbus, Ohio, (1942).

J. E. **Carroll,** Mgr. Constr. Eqpt. Div., Harron Rickard & McCone Co. of Sou. Calif., 3850 Santa Fe Ave., Los Angeles, Calif., (1945).
K. J. **Clapp,** Asst. Sales Mgr., Homelite Corp., Port Chester, N. Y., (1946).
R. **Clarke,** Res. Mgr., Massey Conc. Prod. Co., 122 S. Mich. Ave., Chicago, (1948).
H. S. **Claybaugh,** Div. Engr. Armco Drainage & Metal Prod., Inc., 171 - 27th Ave., S. E., Minneapolis, Minn., (1946).
R. R. **Clegg,** Dist. Sales Mgr., American Lumber & Treating Co., 332 S. Michigan Ave., Chicago, (1946).
M. **Coburn,** (retired) 4117 Park Ave., Indianapolis 5, Ind., (1946)
C. M. **Colvin,** Constr. Supt., Armco Drainage & Metal Products, Inc., 7th & Parker Sts., Berkeley, Calif., (1945).
W. E. **Crawford,** Pres., George Vang, Inc., 623 Grant Bldg., Pittsburgh, Pa., (1946).
D. M. **Crooks,** Field Engr., Douglas Fir Plywood Assoc., 1707 Daily News Bldg., Chicago, (1946).
E. T. **Cross,** V.-P., Armco Drainage & Metal Producs, Inc., Middletown, Ohio, (1946).
T. D. **Crowley,** Pres., Thos. D. Crowley & Co., 37 S. Wabash Ave., Chicago, (1946).

V. W. **Davis,** Mgr. R. R. Sales, Armco Drainage & Metal Prod. Inc., P. O. Box 1343, Atlanta, Ga., (1946).
F. W. **Dayton,** 4614 No. Paulina St., Chicago, (1941)
G. E. **Detzel,** George E. Detzel Co., 2303 Gilbert Ave., Cincinnati, Ohio, (1945).
G. J. **Diver,** V. P. Morrison Ry. Supply Corp., 814 Rand Bldg., Buffalo, N. Y., (1946).
F. J. **Duffie,** Gen. Supvr., Oxweld Railroad Service Co., 230 N. Michigan Ave., Chicago, (1946).
W. D. **DuLac,** Dist. Mgr., Pittsburgh Pipe Cleaner Co., 544 New Center Bldg., Detroit, Mich., (1945).
K. O. **Duncan,** Duncan Hydraulic Roc-Jak, 1350 Wright St., Los Angeles 15, Calif., (1947)
C. R. **Ehni,** Lubr. Engr., The Texas Co., 4126 Bellefontaine Ave., Kansas City, Mo., (1945).
L. T. **Ericson,** Ch. Engr., The Jennison Wright Corp., Toledo, Ohio, (1948).
H. **Eschenbrenner,** Pres., Universal Concrete Pipe Co., 36 Ashbourne Rd., Columbus, Ohio, (1946).
F. W. **Evinger,** R. R. Repr., The Patterson Sargent Co., 1882 S. Normal Ave., Chicago, (1946).

J. D. **Faylor,** Div. Engr., Armco Drainage & Metal Prod., Inc., 444 Insurance Exchange Bldg., Des Moines, Iowa, (1946).
P. **Fields,** Sales Div., Detroit Graphite Co., 3228 N. Broadway, St. Louis, Mo., (1946).
A. J. **Filkins,** Pres., Filkins & Sons, 308 W. Washington St., Chicago, (1927)
F. **Fix,** Sales Mgr., Transp. Dept. Cent. Div., Johns-Manville Sales Corp., 1530 Guild Hall Bldg., Cleveland, Ohio, (1946).
L. **Flanagan,** Detroit Graphite Co., 1500 S. Western Ave., Chicago, (1937).
R. L. **Fletcher,** Strl. Engr., Timber Engineering Co., 1319—18th St., N. W., Washington, D. C., (1947)

L. E. **Goerder,** Supt., George Vang, Inc., R. R. Contractors, 623 Grant Bldg., Pittsburgh, Pa., (1946).

H. F. W. **Hauslein,** Gen. Mgr., H. Hauslein & Associates, 221 N. LaSalle, Chicago. (1948).
W. R. **Hedden,** Gen. Supt. of Constr., Roberts & Schaefer Co., 130 N. Wells St., Chicago, Ill., (1946).
J. F. **Hickey,** Pres., Baker & Hickey Co., 85 E. Gay St., Columbus, Ohio, (1946).
F. W. **Holstein,** Mech. Engr., The Rails Co., 115 Observer Highway, Hoboken, N. J., (1948).
R. R. **Howard,** Div. Mgr., Fabreeka Products Co., Inc., 6432 Cass Ave., Detroit, Mich., (1946).
C. A. **Hubbell,** Sales Mgr., Consolidated Machinery & Supply Co., Ltd., 2031 Santa Fe Ave., Los Angeles, Calif., (1946)
D. A. **Hultgren,** Pres., David A. Hultgren Co., 80 E. Jackson Blvd., Chicago, (1945).

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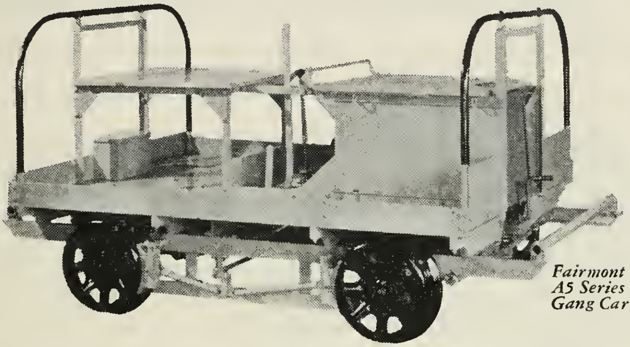

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A. W. Johnson, Asst. Engr., Deleou & Cathers Co., 150 N. Wacker Dr., Chicago, (1942).
H. E. Johnston, Sales & Ser. Engr., Dearborn Chemical Co., 205 E. 42nd St., New York, (1947)
J. E. Kalinka, Vice-Pres., Roberts & Schaefer Co., 130 N. Wells St., Chicago, Ill., (1946).
B. D. Keatts, Reg. V.-P., Intrusion-Prepakt, Inc., 746 Union Commerce Bldg., Cleveland, Ohio, (1946).
G. D. Kemler, V.-P., B. J. Many Co., Inc., 30 N. LaSalle St., Chicago, (1946).
M. G. Kirk, Sales, Pittsburgh Screw & Bolt Corp., Box 1708, Pittsburgh, Pa., (1948).
F. H. Kuhlmann, Dist. Mgr., Dearborn Chemical Co., 1218 Oliver St., St. Louis, Mo., (1946).

J. W. Lacey, Gen. Supvr., The Oxweld Railroad Service Co., 230 N. Michigan Ave., Chicago, (1946).
C. L. LeDuc, Field Sales Mgr., Acorn Refining Co., Cleveland, Ohio, (1946).
F. M. Lehrman, Engr., Reynolds Metals Co. (Ry. Suppl. Div.), 64 E. Jackson Blvd., Chicago, (1945).
F. Leypoldt, Jr., Pres., Carbolineum Wood Preserving Co., 528 W. Highland Ave., Milwaukee, Wis., (1945).
E. J. Littleton, Rep., Jennison-Wright Corp., Granite City, Ill., (1948).
J. S. Loeffler, Sales, Armco Drain Metal Prod., Inc., 4345 Lyndale Ave., N. Minneapolis, Minn., (1948).
L. A. Luther, Serv. Engr., Ingersoll-Rand Co., 1121 Hamilton, Palo Alto, Calif., (1945).
C. A. Lyon, Dist. Mgr., Master Builders Co., 228 N. LaSalle St., Chicago, (1945).

D. B. Mabry, Mgr. Lbr. Sales, T. J. Moss Tie Co., 700 Security Bldg., St. Louis, Mo., (1948).
B. J. Many, Pres., B. J. Many Co., Inc., 30 N. LaSalle St., Chicago, (1946).
C. L. Martin, c/o H. P. Martin & Sons, Box 475, Owensboro, Ky., (1946).
W. L. McDaniel, V.-P., Massey Concrete Products Co., 122 S. Michigan Ave., Chicago, (1945).
E. C. McFadden, Dist. Mgr., Pittsburgh Pipe Cleaner Co., 11110 Longwood Dr., Chicago 43, (1945)
E. J. McGehee, Vice-Pres. & Sales Mgr., Koppers Co., Inc. (Wood Pres. Div.), 700 Koppers Bldg., Pittsburgh, Pa., (1946).
C. A. McTaggart, State Sales Mgr., N. & S. Dak., Armco Drainage & Meal Products, Inc., 705 National Bank Bldg., Sioux Falls, S. D., (1946)
G. McVay, Mgr. R. R. Sales Div., The Ruberoid Co., 307 N. Michigan Ave., Chicago 1, (1937)
F. J. Meyer, Ch. Engr., Ry. Prod. Div., Phila. Steel & Wire Corp., 9 S. Clinton St., Chicago, Ill., (1948).
J. Wallace Miller, Pres., W-M Corp., 608 S. Dearborn St., Chicago, (1946).
H. K. Mills, Pres., Zitterell-Mills Co., Webster City, Iowa, (1946).
J. H. Minton, The Minton Construction Co., Swetland Bldg., Cleveland, Ohio, (1946).
H. Montgomery, Dist. Mgr., The Master Builders Co., 1340 E. 6th St., Los Angeles, Calif., (1946).
Z. J. Montgomery, Arco Co. of California, Ltd., Los Angeles, Calif., (1945).
G. J. Morris, Dist. Engr., Electric Tamper & Equip. Co., Ludington, Mich., (1948).
H. M. Morton, Sales Eng., R. R. Div. Johns-Manville Corp., 1267 Architects Bldg., Los Angeles, Calif., (1945).
H. Mull, V.-P. Sales, Warren Tool Corp., 2119 Bankers Bldg., Chicago, (1946).
J. K. Murdock, Vice-Pres., The Murdock Mfg. & Supply Co., 426 Plum St., Cincinnati, Ohio, (1946).

L. H. Needham, Vice-Pres., The Penetryn System, Inc., 2294 Scranton Rd., Cleveland, Ohio, (1946).

P. A. Orton, Jr., V.-P., Orton Crane & Shovel Co., 608 S. Dearborn St., Chicago, (1946).

G. H. Paris, R. R. Repr., Portland Cement Assoc., 33 W. Grand Ave., Chicago, (1945).
R. Patterson, Vice Pres., Instrusion Prepakt, Inc., 80 E. Jackson Boul., Chicago 4, (1946)
D. D. Powers, Sales Engr., Dearborn Chemical Co., 1101 Union Central Bldg., Cincinnati 2, Ohio, (1947)
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G. H. Redding, Pres., Massey Concrete Products Co., 122 S. Michigan Ave., Chicago, (1946).
W. T. Reeves, Const. Engr. Strl. Steel Dept., Robert W. Hunt Co., 172 W. Jackson Boul., Chicago, (1924)
H. E. Robertson, Mgr., The Robertson Co., 730 E. Gage Ave., Los Angeles, Calif., (1946).
W. O. Robertson, Div. Sales Engr., Armco Drainage & Metal Prod., Inc., Box 1657, Baltimore, Md., (1946).
J. H. Roth, Sales Engr., Buda Co., 492 So. Marion Parkway, Denver, Colo., (1947).
D. A. Ruhl, Sales Engr., Tbr. Structs., Inc., 120 S. La Salle, Chicago, Ill., (1948).
O. C. Rome, National Boiler Washing Systems, 80 E. Jackson Blvd., Chicago, (1945).

O. M. Saxton, Dist. Chgo. Mgr., Timber Structures, Inc., 120 S. LaSalle St., Chicago, (1945).
J. M. Scott, The Arco Co., 614 Delaware St., Scranton, Penna., (1945).
J. W. Shoop, Mgr. R. R. Sales Dept., The Lehon Co., 4425 S. Oakley Ave., Chicago, (1945).
F. C. Smith, Fire Insp., R. R. Dept., Marsh & McLennan, Inc., 231 So. La Salle St., Chicago, Ill., (1948).
B. S. Snow, Pres., T. W. Snow Construction Co., 9 S. Clinton St., Chicago, (1946).
C. E. Southwick, Factory Repr. Homelite Corp., (Port Chester, N. Y.), 624 S. Anderson, Los Angeles, Calif., (1945).
P. C. Spears, Vice-Pres., General Dredging Co., Inc., 2200 La Fontain St., Ft. Wayne, Ind., (1946).
T. R. Stevens, Sales Engr., Tran. Rock Material & Engineering Co., 4016 Flad, St. Louis 10, Mo., (1947)
G. W. Stierer, Mgr., Structural Steel Dept., Robert W. Hunt Co., 175 W. Jackson Blvd., Chicago, (1946).
L. O. Stratton, Lloyds Ry. Supplies, 227 U. S. Natl. Bank Bldg., Denver, Colo. (1947).

W. C. Thatcher, National Boiler Washing Systems, 80 E. Jackson Blvd., Chicago, (1945).
N. Thompson, V-P., Homelite Corp., Port Chester, N. Y., (1946).
R. N. Tracy, Div. Engr., Armco Drainage Metal Products, Inc., P. O. Box No. 2170, Denver 1, Colo., (1946)
F. W. Truss, Sales Engr., Armco Drainage & Metal Prod., Inc., 815 Ambassador Bldg., St. Louis, Mo., (1946).

R. G. VandenBoom, Pres. & Treas., Pacific Union Metal Co., P. O. Box 2616, Terminal Annex, Los Angeles, Calif., (1946).

R. Wagner, Roberts & Schaefer Co., 301 N. Michigan Ave., Chicago, (1946).
R. W. Walb, Pres., General Dredging Co., Inc., 2200 LaFontain St., Ft. Wayne, Ind., (1946).
K. J. Weir, W-M. Corporation, 680 S. Dearborn St., Chicago 5, (1940)
B. E. Whipple, Sales Eng., Pacific Union Metal Co., P. O. Box No. 2616 Term. Annex, Los Angeles, Calif., (1946).
E. R. Wolf, Sales Engr., Marine Engineering & Supply Co., 941 E. 2nd St., Los Angeles, Calif., (1946).
B. R. Wood, c/o The Master Builders Co., 7016 Euclid Ave., Cleveland, Ohio, (1937).

R. W. Young, Jr., R. W. Young Mfg. Co., 20 N. Wacker Dr., Chicago, (1946).

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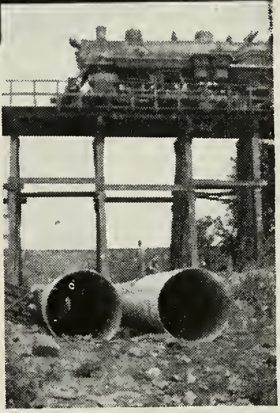

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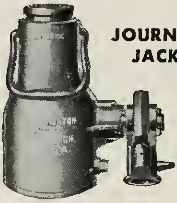

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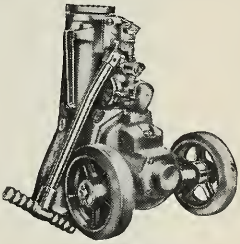

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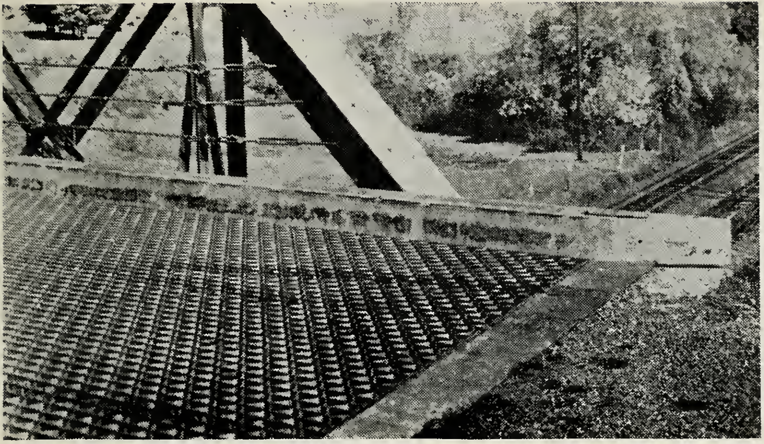

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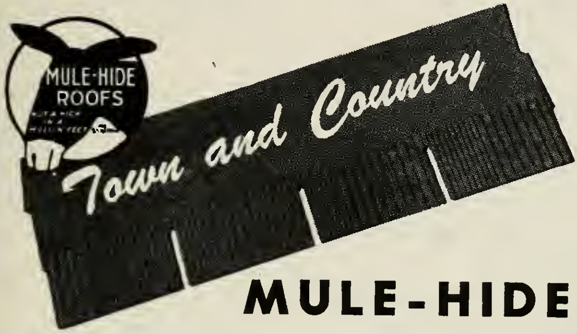

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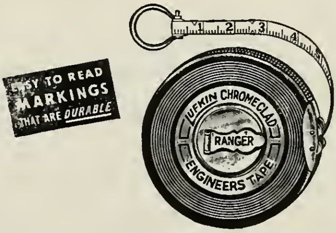

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Bridge and Building Supply Men's Exhibit

Following is a list of members of the Bridge and Building Supply Men's Association that participated in the joint exhibit held during the conventions of the Bridge and Building and Roadmasters Associations:

Air-Reduction Sales Company, New York
American Lumber & Treating Co., Chicago
American Structural Products Company; subsidiary of Owens-Illinois Glass Company, Toledo, Ohio
Armco Drainage & Metal Products, Inc., Middletown, Ohio
Chain Belt Company, Milwaukee, Wis.
Chicago Pneumatic Tool Company, New York
Dearborn Chemical Company, Chicago
Duff-Norton Manufacturing Company, Pittsburgh, Pa.
Fabreeka Products Company, Inc., Boston, Mass.
Fairmont Railway Motors, Inc., Fairmont, Minn.
Harrop Chemical Company, Chicago
Homelite Corporation, Port Chester, N. Y.
Independent Pneumatic Tool Company, Aurora, Ill.
Johns-Manville Sales Corporation, New York
Koehring Company, Milwaukee, Wis..
Koppers Company, Inc., Pittsburgh, Pa.
Lehon Company, Chicago
Massey Concrete Products Company, Chicago
Master Builders Company, Cleveland, Ohio
Mine Safety Appliances Company, Pittsburgh, Pa.
Modern Railroads Publishing Company, Chicago
Overhead Door Corporation, Hartford City, Ind.
Oxweld Railroad Service Company, Chicago
Railroad Products Company, Cincinnati, Ohio
Rails Company, The, New Haven, Conn.
Railway Engineering and Maintenance, Chicago
Railway Purchases and Stores, Chicago
Reade Manufacturing Company, Jersey City, N. J.
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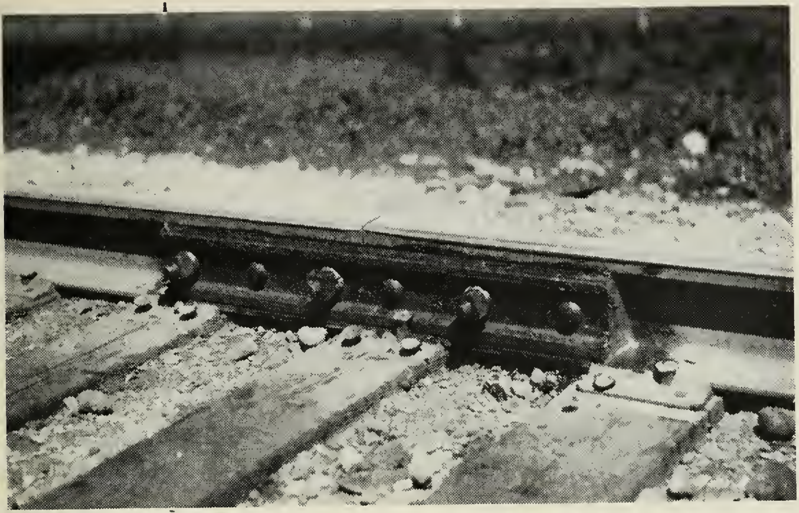

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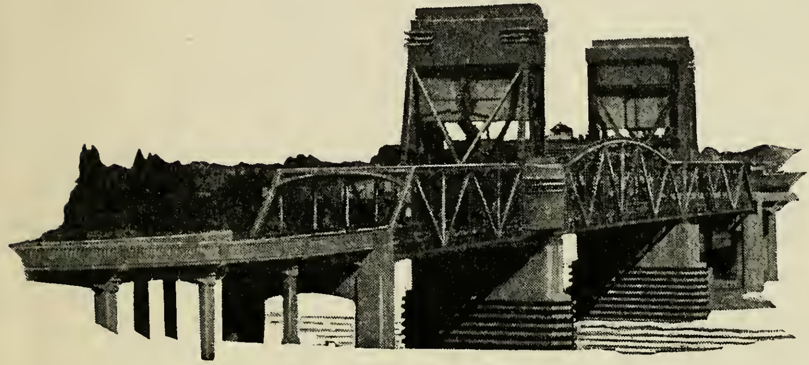

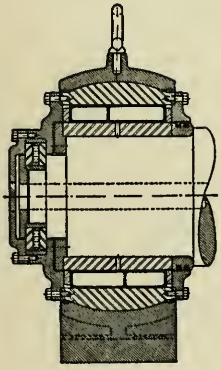

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